THE

ENGINEERING MAGAZINE

VOL. XV. MAY, 1898. No. 2.

THE DEVELOPMENT OF THE TORPEDO-BOAT DESTROYER.

By John Platt.

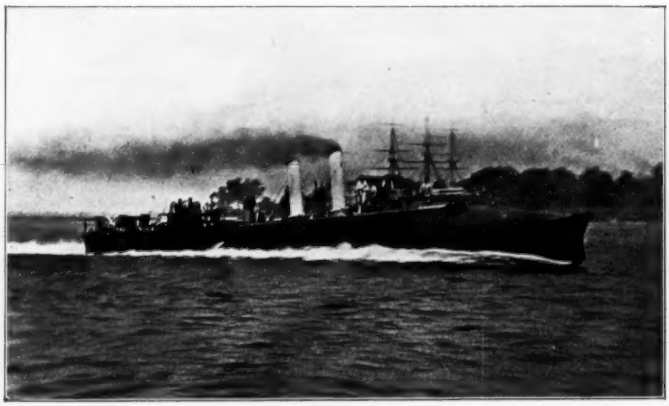
THE torpedo-boat destroyer has been much written about in the daily papers for the past few weeks, and has become of general interest from the fact that Spain is known to possess a number of the very fastest and latest of these useful little boats, which it procured from the Scotch yards. The United States, unfortunately, have not a single one afloat, and are not likely to have for some months to come, when one is expected to be completed. Three others are building, but on March 1 these were but one-tenth finished.

The question has often been asked: What is a torpedo-boat destroyer,—or "destroyer," as it is generally called,—and what functions will it be called upon to perform in war? The special purpose of its English designers was to construct a vessel capable of destroying the enemy's torpedo boats. Up to the present time it has also been so arranged that it can be used as a torpedo boat, the usual tubes being fitted for discharging torpedoes against the enemy's ships.

For its special purpose it must have a greater speed than the ordinary torpedo boat, must be capable of maintaining this high rate of speed in a heavy sea-way, and, finally, must be a suitable platform for carrying quick-firing guns heavy enough to sink other torpedo boats or "destroyers." These should not be less than six-pounders, and at least one twelve- or fourteen-pounder has always been added.

It is both instructive and interesting to sketch the gradual development of the latest "destroyer" from the original torpedo boat. The first torpedo boat on the lines of those now in use was designed and built for the Norwegian government by Messrs. Jno. I. Thornycroft & Co., in 1873, at their yards in Chiswick, England. This boat attained a speed of 15 knots an hour; she was 57 feet long, of

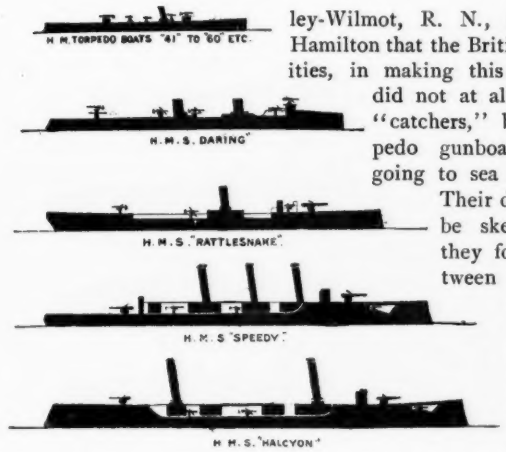
Copyright, 1898, by John R. Dunlap.



ROYAL SPANISH TORPEDO VESSEL "ARIETE." 97 TONS DISPLACEMENT. 1600 I. H. P. 147½x14½x4.9 ft.; speed 26 knots. John I. Thornycroft & Co., Chiswick, London.

16 tons displacement, and developed 90 i. h. p. The next development was in 1877, when the Lightning was built by the same firm for the British government. This boat was 84 feet long, of 27 tons displacement, and developed 460 i. h. p., and a speed of 19.4 knots per hour. In 1878 Messrs. Yarrow raised this speed, with about the same size of boat, to 21.93 knots; in 1880, to 22.16 knots; in 1885, to 25 knots. In 1887 Thornycroft built a much larger boat,—the first fitted with water-tube boilers,—the Ariete, for the Spanish government. She was 148 feet long, of 97 tons displacement, and, with 1,600 i. h. p., made 26.1 knots per hour. She carried four three-pounder quick-firing guns, and two torpedo tubes. Torpedo boats of about this size and speed have also been built by Herreshoff, Normand, Schichau, and others, and represent the usual run of the first-class torpedo boats owned in large numbers by the different navies of the world.

It was first decided to build boats of the "destroyer" class in 1885; those suggested were about the same size and speed as the torpedo boats, and carried two three-pounder quick-firing guns, and three double-barrel Nordenfeldt guns as an alternative to torpedo tubes. These boats, at the time they were built, were called "torpedo-boat catchers." As their speed-capacity was only 20 knots per hour, they were not worthy of this name. From 1886 to 1893 a series of torpedo gunboats, which were generally supposed to have been built as "catchers," were turned out. We have the assurance of Capt. Eard-

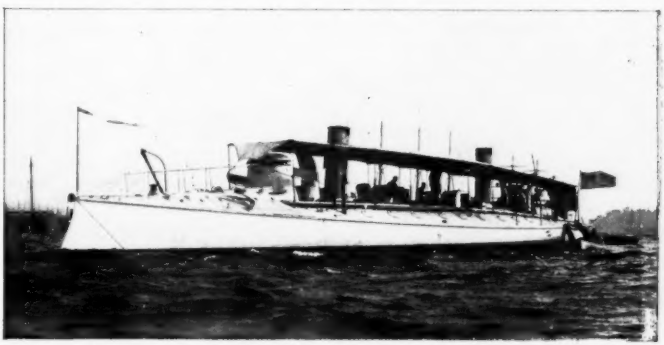


RELATIVE SIZE OF TORPEDO BOATS, TORPEDO-BOAT DESTROYERS, AND TORPEDO GUNBOATS.

ley-Wilmot, R. N., and Lord Geo. Hamilton that the British naval authorities, in making this class of boat, did not at all consider them "catchers," but simply torpedo gunboats, capable of going to sea in any weather. Their development will be sketched here, as they form the link between the attempt in 1885 to build a sea-going boat faster than the torpedo boat, and the successful issue thereof in 1894.

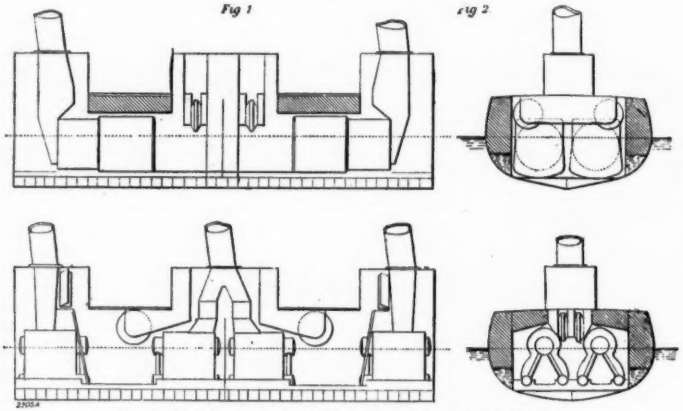
The type built in 1886 was represented by the Rattlesnake. These boats were of 550 tons displacement, and attained a speed of 19 knots with engines of 2,700 i. h. p. They were armed with one four-inch gun, and six three pounder quick-firing guns, besides torpedo tubes.

It was found necessary to increase the size of the next series of boats, so that more power might be obtained; consequently the displacement was increased to 735 tons. Between 1888 and 1890 a considerable number of these boats were built by the British govern-



U. S. TORPEDO BOAT "CUSHING." 105 TONS DISPLACEMENT. 1720 I.H.P.
138 ft. 9 in. x 14 ft. 10 in. x 5 ft. 3 in.; speed 22 knots. Herreshoff, Bristol, R. I.

ment, commencing with the Sharpshooter. Their length is 230 feet, beam 27 feet, draught 8 feet 3 inches, displacement 735 tons, and their engines were to develop 4,500 i. h. p.; but, difficulties being experienced with the locomotive boilers, which up to this time had been used generally in boats of this class, it was found impossible to obtain more than 3,700 i. h. p., and the speed did not exceed 20 knots per hour. It was with considerable difficulty that even this power was obtained. This led in 1892 to eleven new vessels of this type, increased in displacement to 810 tons, chiefly to provide more accommodation for the machinery. Ten of these boats were fitted

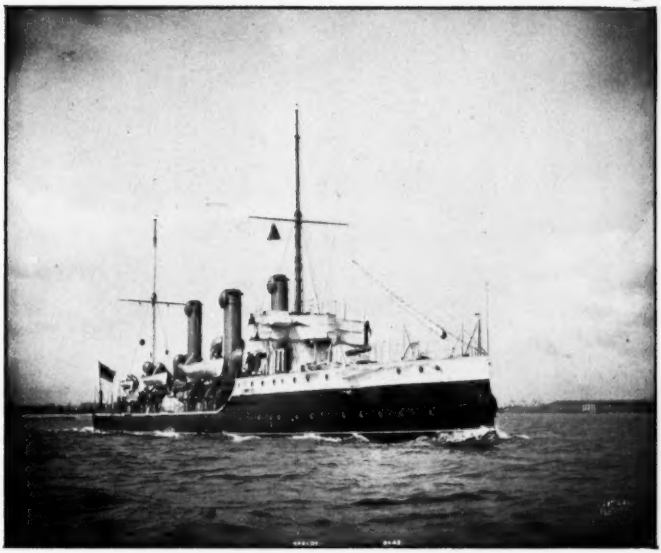


A COMPARISON OF LOCOMOTIVE AND WATER-TUBE BOILERS.

The water-tube boilers give 1000 h.p. more, with less weight, and in the same space.

with locomotive boilers, which developed on an average 3,700 h. p., giving a speed of 19½ knots. The remaining boat, the Speedy, built by Jno. I. Thornycroft & Co., is of peculiar interest from the fact that she was the first large boat in the navy fitted with water-tube boilers. The sketch plan on this page shows the relative spaces taken by the locomotive and water-tube boilers. The large excess of power obtained by the boilers in the Speedy undoubtedly led in a large measure to the working out of the present form of "destroyer."

The Speedy, of which a very good idea can be obtained from the illustration on page 193, is 230 feet long, 27 feet beam, 8 feet 8 inches draught, and 810 tons displacement. She was fitted with eight Thornycroft boilers, each having 25.5 square feet of grate surface, and 1,840 square feet of heating surface. On trial, 4,700 h. p. was easily developed, and with this a speed of 20½ knots was obtained. At a later date, in ordinary service, after the navy stokers

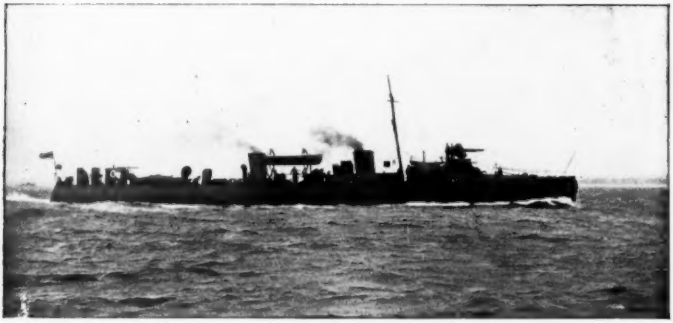


H.M.S. SPEEDY—TORPEDO GUNBOAT. 810 TONS DISPLACEMENT. 4500 I.H.P., FORCED DRAUGHT.

230x27x8⅓ ft.; speed 20½ knots. John I. Thornycroft & Co.

had become accustomed to the new type of boiler, there was no difficulty in developing 5,000 h. p. Thus an increase of 1,300 h. p. had been accomplished, with a reduction of 20 tons in the weight of the boilers. The i. h. p. developed per ton of boiler averaged 43.9. Under natural draught, on a trial lasting 20 hours, the coal consumed was only 1.58 pounds per i. h. p., which compares favorably with the best marine practice.

In further effort to obtain speed, boats of the "Halcyon" class, of 1,070 tons displacement, were built, but did not prove very successful. During all this time the speed of the ordinary torpedo boat had rapidly increased, but there had been no corresponding increase in the speed of the catchers. This led to the working out, in 1893, by Thornycroft and Yarrow, respectively, of the Daring and Havock, the first of the "destroyers" proper. The Daring is 185 feet long, 19 feet beam, 6 feet 3 inches mean draught, and 220 tons displacement. The engines on trial developed 4,735 i. h. p., and a speed of 29.268 knots per hour. The Havock attained a speed of 27.6 knots per hour on her trial trip. The armament consists of one twelve-

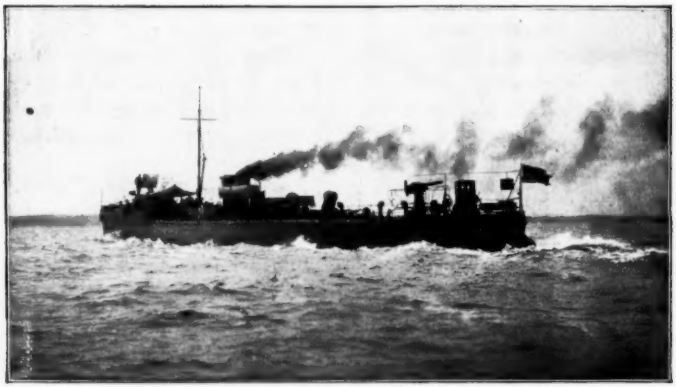


H.M S. "DARING"—TORPEDO-BOAT DESTROYER. 220 TONS DISPLACEMENT.
4735 I.H.P.
185x19x6¼ ft.; speed 29.26 knots. Built by Thornycroft.

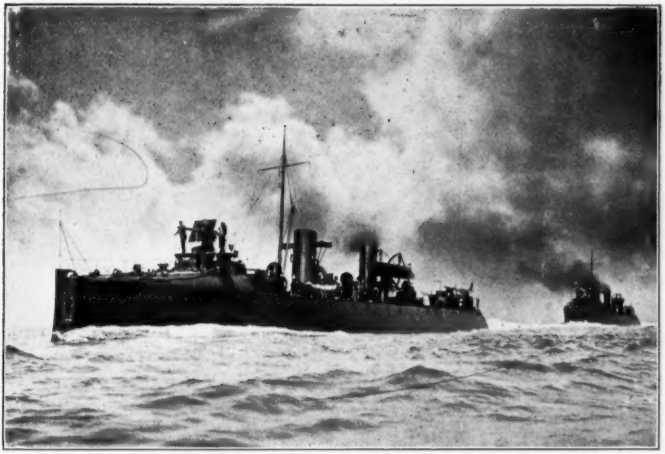
pounder quick-firing gun, mounted on the conning tower, and five six pounder quick-firing guns, four on the broadside and one on the centre line aft.

The next development was in the Boxer class, in which the boats were slightly increased in size. The length was 200 feet, beam 19 feet, mean draught 7 feet, and displacement 250 tons. The engines developed 4,700 h. p, and a speed of 29.314 knots was obtained,—an average of six runs on the measured mile.

The present standard and most economical English "destroyer" is represented by the "Desperate" class, designed by Thornycroft.



H.M. TORPEDO-BOAT DESTROYER "HAVOCK." 240 TONS DISPLACEMENT.
3400 I.H.P.
180x18.5x7.5 ft.; speed 27.6 knots. Yarrow & Co., Poplar.

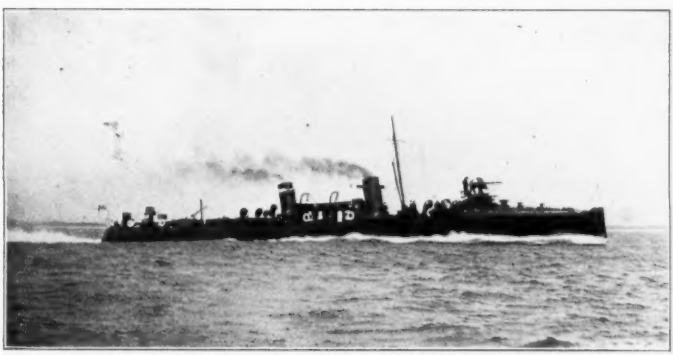


H.M. TORPEDO-BOAT DESTROYER "BOXER," "BRUISER" ASTERN. 250 TONS DISPLACEMENT. 4700 H.P.

200x19x7⅔ ft.; speed 29.31 knots. Built by John I. Thornycroft.

The requirements are that a speed of 30 knots shall be maintained for three hours, with a load of 35 tons on board, and with a coal consumption of not more than 2½ pounds per i. h. p.

The Desperate is 210 feet long, 19 feet 6 inches beam, and 7 feet 2 inches mean draught, with trial displacement of 275 tons. Twin screws are driven by engines with high pressure cylinders 20 inches diame-



H.M. TORPEDO-BOAT DESTROYER "ARDENT." 265 TONS DISPLACEMENT. 4300 I.H.P.

200x19x7 ft.; speed 27.8 knots. John I. Thornycroft & Co.

TORPEDO-BOAT DESTROYER "HORNET" OVERTAKING TORPEDO GUNBOAT "SEA GULL."

ter, intermediate 29 inches two low-pressure 30 inches diameter all by 18 inches stroke, the revolutions varying between 390 and 400. Three water-tube boilers, with 63.5 square feet of grate surface and 4,020 square feet of tube surface, furnish steam at 220 pounds pressure. On the three hours' trial a speed of 30.5 knots per hour was attained, with a coal consumption of 2.43 pounds per i. h. p.

These boats carry the standard English "destroyer" armament of one twelve-pounder quick-firing gun, and five six-pounder quick-firing guns, with two torpedo tubes for eighteen-inch Whitehead torpedoes.

H.M. TORPEDO-BOAT DESTROYER "SPARROWHAWK." 300 TONS DISPLACEMENT. 6000 I.H.P.

210x21 7x5.3 ft.; speed, 30 knots. Laird Bros., Birkenhead.

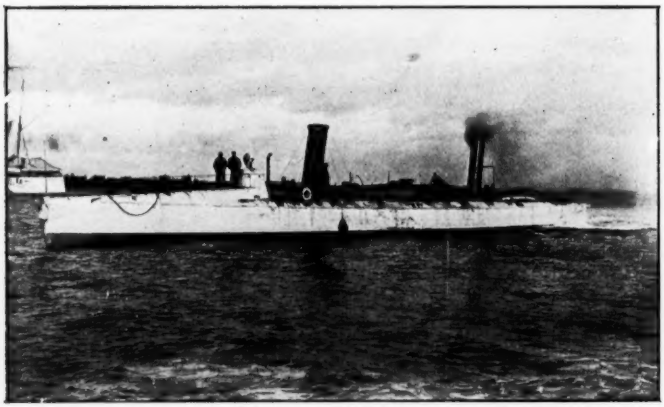
U. S. DYNAMITE CRUISER VESUVIUS. 930 TONS DISPLACEMENT. 3794 I.H.P., FORCED DRAUGHT.

Length 251.9 ft., beam 26.5, draft 10.7; speed 22.5 knots. Built by Wm. Cramp & Sons, Phila., Pa.

They have proved, after the severest possible trials in a heavy sea-way, thoroughly efficient sea boats and in every way adapted to the carrying of their guns and torpedo tubes. This is particularly referred to here, as later it will be touched upon in connection with the question of

TORPEDO-BOAT DESTROYER OF THE "QUAIL" TYPE. 300 TONS DISPLACEMENT. 6000 I.H.P.

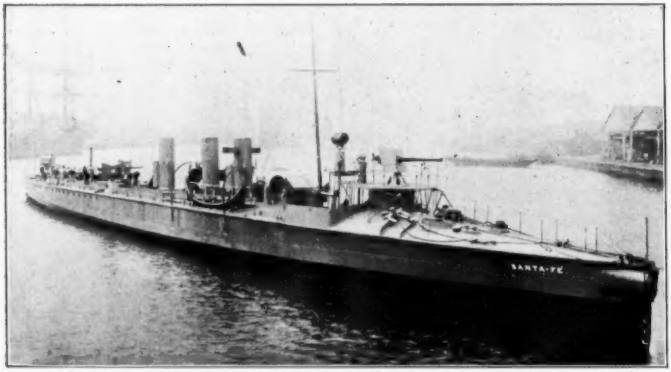
210x21.7x5.3 ft.; speed 30 knots. Laird Bros.



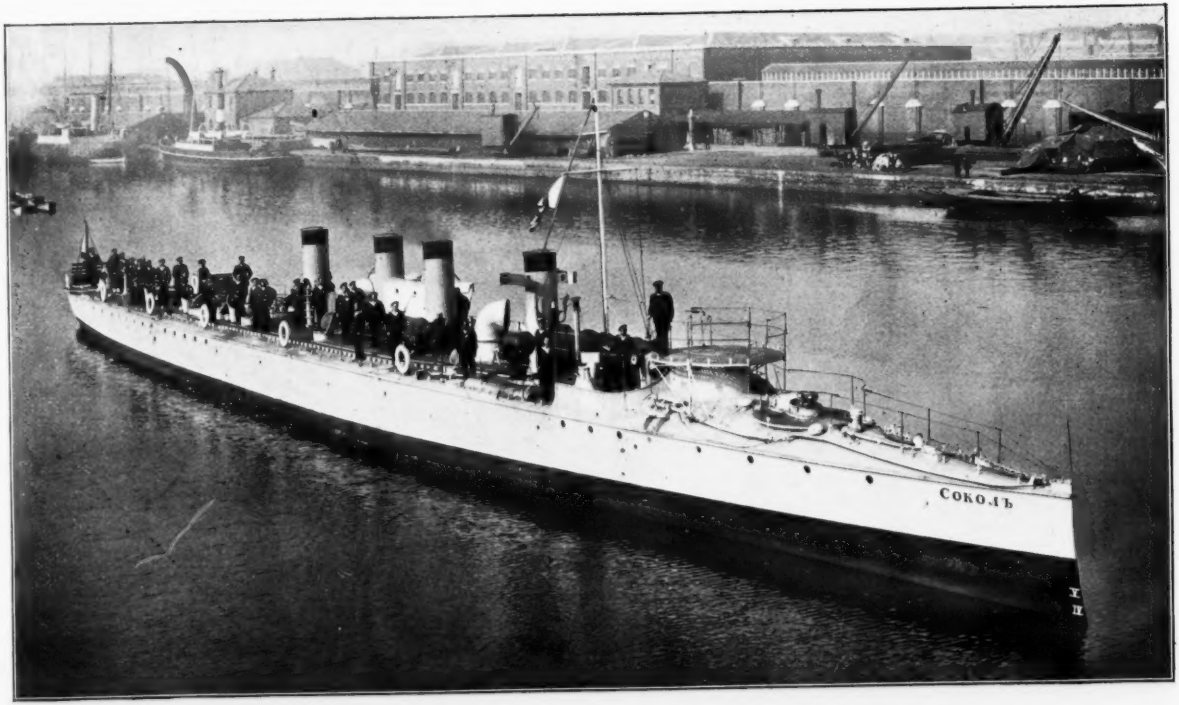
U. S. TORPEDO BOAT "ERICSSON." 120 TONS DISPLACEMENT. 1800 I.H.P.
150x15½x4¾ ft.; speed 24 knots. Dubuque Iron Works.

economy in coal consumption,—a very vital question with boats of this class, and one that has too often been lost sight of.

A boat of a somewhat different character is the Sokol, built by Yarrow for the Russian government. She is 190 feet long, 18 feet 6 inches beam, 7 feet draught, and of 240 tons displacement. The average speed on the three-hour run was 29 knots, but, when forced to 4,490 h. p., she ran for a short time at 30.3 knots. Being fitted with eight



ARGENTINE TORPEDO-BOAT DESTROYER "SANTA FE." 4200 I.H.P.
190x19½ ft.; speed 26 knots; ½ in. armor protecting engine and boiler space. Yarrow & Co.



RUSSIAN TORPEDO-BOAT DESTROYER "SOKOL." 240 TONS DISPLACEMENT. 4490 I.H.P.
190x18.6 ft.; maximum speed 30.3 knots. Yarrow & Co., Poplar.

water-tube boilers, instead of three as in the Desperate, she is obliged to have four smoke-stacks.

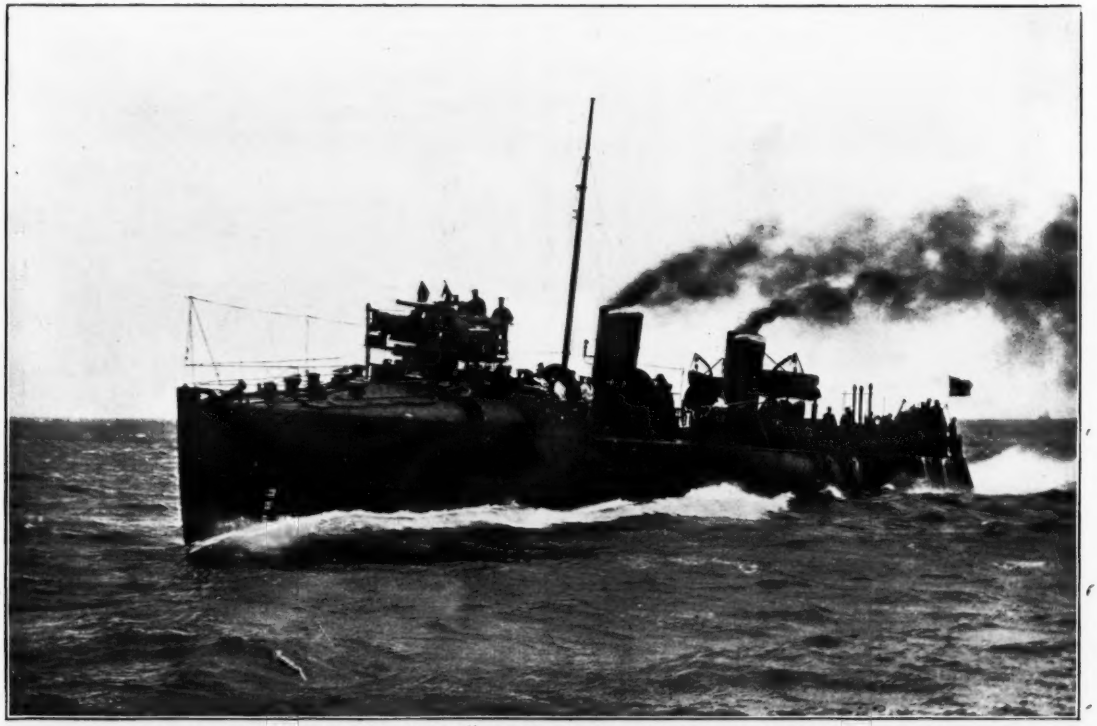
The Furor and Terror, built by J. & G. Thompson, of Glasgow, for the Spanish government, are 220 feet long, 22 feet beam, 5 feet 6 inches draught, and of 380 tons displacement. With 6,200 h. p. the speed was 29 knots per hour. The armament consists of two fourteen-pounder quick-firing guns, two six-pounder quick-firing guns, two 30 mil. auto. quick-firing guns, and two torpedo tubes. They carry a load of 75 tons, and are a good deal bigger and heavier than the English boats of this class.

The Audaz, Osado, Pluton, and Proserpina, later boats by Thompson, built for Spain, are 225 feet long, 22 feet 6 inches beam,

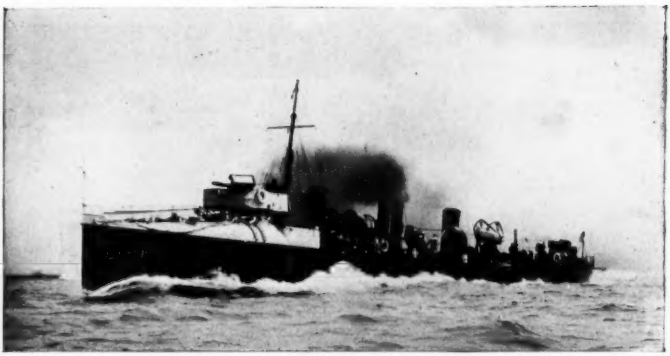
H.M. TORPEDO-BOAT DESTROYER "SHARK." 280 TONS DISPLACEMENT. 4100 I.H.P. 200x19.5x5.2 ft.; speed 27.6 knots. J. & C. Thompson, Glasgow.

5 feet 9 inches draught, and of 400 tons displacement. On trial, with 7,500 h. p., they made a speed of 30.3 knots per hour. The armament is the same as that of the Furor and Terror, the coal capacity being 100 tons.

From the foregoing it will be seen that "destroyers" of the present class vary between 275 tons and 400 tons trial displacement, with an average speed of 30 knots on a three-hour run, and this with a coal-consumption of not more than 2½ pounds per i. h. p. As a matter of fact, on recent trials of boats of the smaller class, the speed of 30 knots has been attained on 2.06 pounds of coal per i. h. p. As the size of the boat increases above 300 tons, it is found that more power



H.M. TORPEDO-BOAT DESTROYER "FAME," AT FULL SPEED. 272 TONS DISPLACEMENT. 5400 I.H.P.
210x19.6x7.2 ft. Average speed on three hours' trial 30 knots. John I. Thornycroft & Co., Chiswick, London.

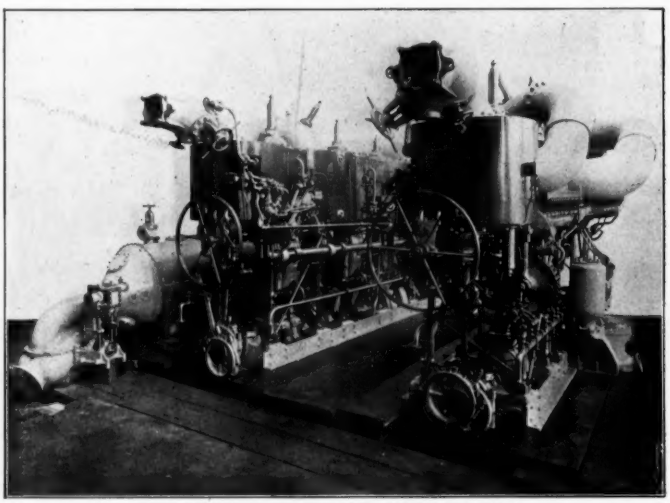


TORPEDO-BOAT DESTROYER "WHITING" STEAMING 31.3 KNOTS. 300 TONS DISPLACEMENT. 5900 I.H.P.

205x20⅔x6½ ft. Built by Palmer's Shipbuilding and Iron Co., Ltd., Jarrow-on-Tyne.

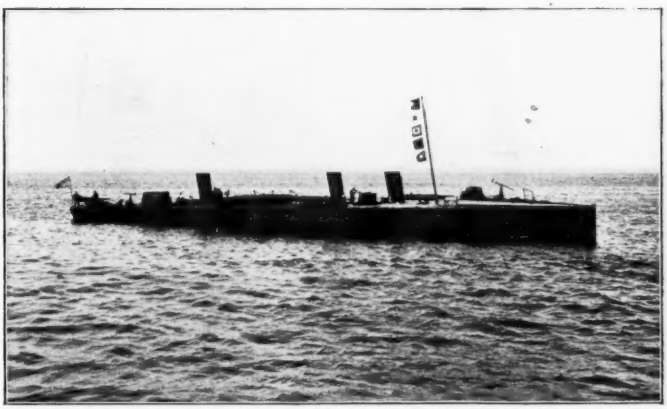
in proportion is required for a given speed, and hence a greater coal-consumption. In this connection the following quotation from a paper read by Mr. Thornycroft some years ago is of peculiar interest:

"The very large power required for the torpedo-boat destroyers —of which the Daring may be taken as an example—to attain their



THE ENGINES OF A TORPEDO-BOAT DESTROYER.

Palmer's Shipbuilding Co., Jarrow.



U. S. TORPEDO BOAT DUPONT. 185 TONS DISPLACEMENT. 3500 I.H.P. 170x17x5.5 ft.; speed 28 knots. Herreshoff, Bristol, R. I.

speed indicates the enormous difficulties which bar the way to attain equal speeds in larger vessels, for, although there is economy of power to be obtained generally by increased size of vessel, this rule is subject to complete reversal under certain conditions, which can be explained by Froude's law of corresponding speeds, which show that, although we can attain a speed of 30 knots economically in a vessel of about the size of the present destroyers, if we increase the displacement three or four times the performance is far less satisfactory; and, if we go on increasing, we shall not arrive at a size favorable to this speed, until we get to the largest dimensions."

A leading article in London *Engineering* made the following remarks, which it will pay to keep in mind during the present crisis:

"This statement, taken in conjunction with a previous expression of opinion made by the author as to the limitations of efficiency in the screw propeller — limitations which appear to have been very closely approximated to in the destroyers — seems to show that a halting-place is in sight in regard to dimensions and speed of vessels of the torpedo class. The prospect is not unwelcome from many points of view. So long as it was sufficient to get a faster boat simply by the brute-force principle of bigger boats and bigger engines and boilers, the least well-informed builders, having the command of cheap labor and cheap materials, could always go one better than their less favorably situated competitors in regard to commercial considerations by adopting the designs of better-informed constructors and adding somewhat to the dimensions. This is notoriously the

CHILIAN DESTROYER "CAPITAN ORELLA." 300 TONS. 6000 I.H.P. 210x21½x5¼ ft.; speed 30.17 knots. Laird Bros.

method that has been followed in certain cases of late." And, it may be added, not always with success.

In this general connection the results of the official steam trials of the English "destroyers" during 1897 will be of interest. The best result obtained by the Laird boats of 300 tons trial displacement was a consumption of 2.41 pounds of coal per i. h. p. per hour. Of the five boats by Palmer, each of 300 tons trial displacement, the best result was 2.42 pounds per i. h. p. per hour. The later of the Thornycroft boats, of 275 tons trial displacement, were able to obtained a speed exceeding 30 knots on a coal-consumption of 2.06 pounds per i. h. p. per hour. Several factors may have combined to thus keep down the consumption, but the fact remains that the boats of the smaller displacement, which Mr. Thornycroft had in mind when he made this statement, were by far the most economical.

A trial trip last summer in the North sea, on a boat of the type of the Desperate with half a gale blowing, very clearly showed that a boat of this size, with plenty of free-board, is capable of running satisfactorily at the high rate of speed called for.

The "destroyers" built in the south of England, and on the Thames, run their trial trips off the Nore. The boat is taken out of the dock by the officers of the Royal navy. The machinery is all in the care of the builders, who are responsible for the run. They provide their own pilot, who takes charge of the steering when she is put

on the measured mile. If the boat has not been out before, she at once steams down to Sheerness, where she is swung for the adjusting of compasses. Directly this is done, the boat gets under way, and all becomes activity and life; orders are given for closing hatches and for starting the fans which produce the forced draught. From previous experiences it is known that it takes about half an hour to get everything in full swing, and in about that time the trial will begin. The boat has to run for three hours, and to be run over the measured mile six times, three with the tide, and three against it; the revolutions are taken from start to finish, and are taken regularly while on the mile; at this time indicator cards are also taken. After the first two runs the man in charge of the machinery is able to tell what rate of speed he is making, and, if he is not satisfied, he at once tries to turn his engines faster; before the last of the six runs, he will have been able to tell just what average of revolutions he must maintain to give him a speed a little in excess of the contract speed. It is now nearly always the case that, by the end of the runs on the mile, they find that the engines can be slowed down a little for the remainder of the trial and the necessary speed obtained.

It does not at all follow that this speed will be attained on the first trip. On some of the early "destroyers" from twelve to twenty attempts had to be made before all worked satisfactorily. Unfortunately, in a number of cases, the accidents to the machinery have been followed by serious results, and many are the poor fellows who have been badly scalded from the cracking of a cylinder or the breaking of a steam pipe. If this is the case in times of peace, when everything is favorable, how much more is it the case when running in the face of an enemy. Owing to the extreme liability of these boats to machinery trouble while running at high speed, each navy must possess a large number, so that, though a percentage of the boats should be disabled, the fleet may still be safe.

The British naval authorities have had so much experience with this class of work that they have found it wise to put the running of all torpedo boat and "destroyer" trials solely in the hands of the engineers and constructors of the navy. All that the line officers are called upon to do is to take charge of and navigate the boat. In England this is generally conceded to be their proper work. The admiralty does not allow them to have anything to do with the decision as to the acceptability of the boats from the contractors.

It is much to be regretted that it is impossible to give illustrations of any American "destroyers," and it is sincerely to be hoped that the present crisis will bring about a more consistently and continuously liberal policy in naval matters.

RAILROAD FARES AND PASSENGER TRAVEL.

By H. G. Prout.

IT has been suggested that I say something along the line of Mr. Stevens's article in the March issue of THE ENGINEERING MAGAZINE on British railway fares and their influence on traffic. I attack the subject with a little reluctance. Macaulay said of Dr. Nares: "He employs more words in expounding and defending a truism than any other writer would employ in supporting a paradox." It is so obvious that there is a close inverse relation between fares and the volume of travel that one takes a risk of calling down upon himself the same kind of criticism, if he undertakes to demonstrate that there is such relation. Mr. Stevens has escaped that kind of criticism by telling us little of this relation in Great Britain. He gives certain interesting figures about passenger travel and passenger rates, but nothing by which we can accurately, or even approximately, measure their growth or decline, mainly, we suppose, because neither he or anyone else can give such figures.

It is the old story of attempting to analyze British railroad statistics. You are confronted with the fact that no unit of movement, either passenger-mile or ton-mile, is given. You can only guess what that movement has been. Mr. Stevens's nine-mile average passenger journey is a guess. You may say that at least you have the number of passenger journeys, and can compare them from year to year; but, in fact, you have no comparable figures. All the statistics of passenger journeys in Great Britain are given "exclusive of season and periodical tickets." I once tried to estimate the total number of passenger journeys in Great Britain. (I was never so rash as to try to estimate the passenger-miles, for I would not even guess at the average journey.) I found that 864,500,000 passengers were carried in the United Kingdom in one year (1892) exclusive of season and periodical passengers, of whom there were 1,612,510 I guessed that each of these latter made 300 trips a year,—apparently a moderate estimate,—and that therefore the whole number of season and periodical journeys was 480,000,000. So I got at a total of 1,344,500,000 passenger journeys made in the United Kingdom in one year. Mr. Acworth pointed out that I had deliberately and voluntarily gone out of my way to make a blunder by not first ascertaining that these season tickets are so often for a week or two, and not for a year, that any estimate of the total journeys is misleading.

Further, we can get at the average passenger fare or freight rate

by guessing at our premises and expanding them. Some years ago a distinguished member of the American Society of Civil Engineers wrote a famous book on this plan. He guessed at certain fundamental facts, and then, on the basis of these facts, he proceeded to compare English and American railroads through one hundred and forty pages of type, with many tables and diagrams, to the immense interest and instruction of the half-informed. I have not seen that book quoted for at least five years.

The best comparative figures that we can get at are these: The average passenger fare in the United States in 1896 was, according to Poor, 2.034 cents a mile; according to the interstate commerce commission, 2.019 cents. The average in England was estimated by Mr. Acworth, after careful analysis, at between 1.3 and 1.4 cent; "that it cannot be higher than 1.6 cent I feel absolutely sure."

But Mr. Stevens does tell us many things about the course and condition of British passenger traffic that are worth while; for example, about reduced-rate tickets for workingmen and for excursions, and about the growth of third-class travel, all of which it is well to state for the benefit of the rising generations of general passenger agents, traffic managers, and other readers.

Before leaving Mr. Stevens, it may be well to remind him and the reader that we do have in the United States two well-marked classes of passenger accommodations and passenger rates, in constant and great use, and that the British writer is constantly making mistakes by ignoring this fact. The day-coach travel and the parlor-car and sleeping-car travel make two classes just as distinct and as characteristic as the first-class and third-class travel in England. Whether or not the passenger goes by one or the other of these classes is a mere matter of the money paid, exactly as it is in England. There a peer may (and, in fact, often does) go third class, while the man who wants to seem to be a peer will probably go first class. Really, it is mostly a matter of comfort, there as here. You buy the amount of comfort that you care to pay for; and for 500 miles it is hard to beat the comfort of an English first-class compartment, especially if you care to invest a shilling on the guard and secure a coupé to yourself.

It may be well also to glance at the seclusion notion, which is again brought up by Mr. Stevens. The notion that in a British compartment you have more seclusion than in the American open car is one of those cherished delusions of the Briton, much like, for example, the notion that we do not have cheap cabs in the United States because we cannot drive well enough, or like the delusion of some of the correspondents of one of the great English engineering journals that we make wonderful locomotive records in America be-

cause the miles are short. You can have seclusion in Great Britain if your party fills the compartment, or if you tip the guard, but it is hard to find more disagreeable publicity in traveling than sitting in a compartment facing and jolting against the casual stranger who straggles in, be he Englishman or traveling American.

We cannot hope to discover the relations between passenger fares and passenger travel even in the United States, but we can at least know what the fares and what the movements have been at various periods, and so try to discover the relation between them.

From 1886 to 1896 the average passenger rate fell 7½ per cent. and the passenger movement increased 35 per cent., but it would be assuming a good deal to say that one was the cause of the other. In fact, the population of the United States gained 24 per cent. in the same time, and an important part of the increase in passenger travel must be attributed to that. It is a common experience that passenger movement in cities gains faster than the population, owing to the increase of facilities for movement; but from 1886 to 1896 passenger travel per mile of railroad worked actually decreased 7 per cent. The travel did not gain as fast as the opportunities to travel, in spite of lower fares and of greater population.

Perhaps it is not quite fair to take the whole territory of the United States. Let us take, then, some part of the country where conditions are perhaps closer to the normal. For example, in Massachusetts, the passenger miles per mile of railroad worked amounted to 297,500 in 1886, and in 1896 they had risen to 375,000,—a gain of 26 per cent. This is a fair measure of the relative use of the railroads by travellers; it had increased about 26 per cent., while in the whole United States it decreased 7 per cent. In the same time the population of Massachusetts gained about 28 per cent., and the average fare fell 5 per cent.

We see the impossibility of establishing any general relation between rates of fare and passenger travel, and it is just about as difficult to find special cases that prove much. In the nature of things a standard steam railroad very seldom makes any considerable reduction of fare for regular service extending over some time and not complicated with other conditions. Of course, we are all familiar with cases of a heavy passenger movement stimulated by low excursion rates; but, where this has lasted for some weeks, or months, it must have been because there was some object in going on the excursion other than to take advantage of a low rate.

The elevated railroads of New York give us a pretty simple case of rates and movement. In December, 1880, the commission hours (the hours during which 5-cent fare was charged) were increased two

hours a day, making the total six hours instead of four. The result in the average receipt per passenger carried was a decline from 7.59 cents to 7.02. The increase in the number of passengers carried during the next year was 24.3 per cent.; the year following, the fares remaining stationary, the number increased 14.2 per cent.; the next year 6.6; and after that there was no considerable increase in passengers carried until 1886 and 1887. Such increase as took place was perhaps due mostly to growth of population. But at various dates in the last half of 1886 the rate was reduced to five cents for all hours of the day on all lines of the system. The passenger movement increased from 108.7 millions a year to 159.6 millions, or almost 47 per cent. The effect on the revenues we need not consider here. This is a case where obviously the movement of passengers was greatly stimulated by reduced fare.

But the case was very peculiar. In some ways it could not be duplicated anywhere else in the world,—not in London, or Chicago, or Paris, or Berlin. The fares were cut in two, there was a vast population to serve, the existing modes of travel were wretched,—we have all forgotten how slow and infrequent and crowded and dirty the old horse-cars were,—and, finally, the shape of the city made it possible to concentrate much of the travel on the lines of the elevated. Such a set of conditions on such a scale could not be found elsewhere, and probably never will be found again.

Another important example in city travel has lately occurred in New York in the conversion of the Fourth avenue horse-car line into an electric line. The change was immediately followed by a great increase in passenger movement, although there was no reduction of fare. In February, 1897, the passengers carried by horse cars on the whole Fourth avenue division were 1,473,713; in February, 1898, with electric service down only to Astor place, the passengers carried on this division were 2,931,538. The movement had doubled, but the fare was the same. This example shows us how dangerous it is to reason from part of the facts.

But to return to railroads proper. Most of us have opportunities to observe the effect of cheap rates on the human mind. We constantly see our friends set a-going by the mere fact that they can get a cheap return ticket, on account of some convention excursion or the like. We are all familiar with the remarkable effect of a cheap family-ticket or 50-trip ticket on the minds of the ladies of our families. They will go to town once, if they must pay 50 cents for the return ticket, but three or four times, if they have a special return ticket reducing the fare to 34 cents. The male accountant is sometimes tempted to doubt the benefit to the community of these special rates,

but the benefit to the railroads is unquestionable. Trains are filled, or, at least, made to earn something at hours when they would otherwise run practically empty.

It is apparent to any man of observation and experience that the copious issue of commutation tickets at three-quarters of a cent a mile and 50-trip family tickets at 1⅓ cents a mile has a great effect in stimulating travel in the vicinity of a city. It gets people to move, and, further, it builds up the country with a population having an inclination to stir about and the means to gratify that inclination. But, further than this, we cannot say that in the United States special cheap fares have done much to set the masses moving. We may leave out of consideration long-distance special-convention excursions and the like. These are merely incidental and sporadic, and cannot be counted on as part of a regular and permanent traffic.

It has long seemed to many observers that the railroads might do a good deal more than they do now to create travel by special rates. Obviously, the true principle in this is to offer attractions that will induce folks to go somewhere when they would otherwise stay at home. The English do this on a scale and in a variety of ways that have never been approached in the United States. I need not repeat here the list of special-rate tickets that Mr. Stevens gave in the March issue of THE ENGINEERING MAGAZINE. It is enough to say that people are inclined to go to the seashore, to the lakes, to the highlands, to the cathedral towns, to town for the theatre, and to the country for golf, by tickets as cheap as one-half or three-quarters of a cent a mile,—rates which are approached in the United States only by the regular commutation tickets.

But, when all is said, it is useless to lay down any general proposition,—such as, for example, that, if you reduce fares, you will increase travel. Perhaps you will, and perhaps you will not. One of the clearest-headed transportation men of my acquaintance, a very successful manager of city railroads, who is often called in to advise, lately said to me: "I warn my clients that they cannot be guided by my experience, except in generalities; every case is different." Most of us, as we grow older, acquire more distrust of general solutions, by theory, of such questions as that of getting and handling traffic. Voltaire said: "All general statements are false, and probably this one is also." We learn to try to discriminate among our facts. In Texas, for example, the passenger miles per mile of railroad are about 33,000; in Massachusetts they are 375,000. If we carried people of Texas free, we could not get any such movement as the people of Massachusetts pay for, because the population per square mile in Texas is 10, while in Massachusetts it is 300. Again,

to the people of some regions two and one-half cents is a considerably larger sum of money than is five cents to the people of other regions. Although Belgium has 1.88 times as many inabitants per square mile as Massachusetts, it may be that there are more people per square mile in Massachusetts who would spend 50 cents to travel a given distance than there are in Belgium who would spend 25 cents for the same journey. All of this means that there are a great many things which enter into building up passenger travel, besides low fares.

Again, if we carried passengers as cheaply as they are carried in Belgium or in India, it is not likely that we could provoke so great a passenger movement per mile of railroad, even in Massachusetts; and this for at least two reasons.

The greater wealth of American and English people permits them to pay more for railroad travel, and their time is worth more to them than the time of a poorer people. Therefore, a reduction in fares would not be so important to them as to a poorer people, and would not so much affect their movement, because they can afford to spend more money to travel, and they cannot afford to spend so much time. At least, this is a plausible theory.

The second reason is that there are actually fewer people to draw upon; and this brings us to some very remarkable facts. Let us take, for instance, the case of Belgium. The population there is 564 persons per square mile, while in the whole United States it is only about 24, and in Massachusetts it is 300. The railroads there number 5.4 miles for each 10,000 inhabitants, the same figure being 26.6 in the United States. The average passenger fare there is as low as 0.95 cent per passenger-mile. The average in the United States is 2.019. The result is that, with an average passenger train load of 70 passengers, the yield from passenger business on Belgian roads is only 71 cents per train-mile. In the United States, with a train load of 39 persons, the train-mile earnings amount to 98.59 cents. We see that it is a matter of very serious question whether or not fares as low as those of Belgium, would create as great a passenger movement in a country of sparser population; it is almost certain that it would not create a passenger movement which would pay the railroads. They would lose money on passengers, and would have to make it up in freight, or else cease to run. But it is probably a safe proposition that it is immensely more important to a nation to have cheap freight rates than to have cheap passenger rates. In Belgium, for instance, the earnings per freight train mile amount to $1.74 with an average train load of 136 tons, from which we deduce an average ton-mile rate, for freight, of 1.27 cents; but in the United States the average freight rate has fallen to 0.806 cents.

But we find in India figures even more remarkable than those of Belgium. We find there much the lowest passenger rate in the world, —namely, 0.338 cent. This is taking the gold value of the rupee at 26 cents, which was its average value in the year for which this passenger rate was deduced. This rate is only $\frac{6}{10}$ of the average passenger rate in the United States, and a still lower average rate would be found on the great Indian lines situated in the region of densest population.

But in that country even this wonderfully low rate is perhaps profitable, for the average train load was 150 persons in the year in which it was 38 persons in the United States, and it is possible to do business at such rates if you can get heavy loads, move them at infrequent intervals, move them slowly, and carry the mass of the passengers in bare cars, seated on benches. But, of course, such a traffic could be created only in a region of dense population. The greatest development of the Indian railroads is in regions having more than 500 people per square mile, while great regions of India have more than 800 people per square mile. Given such conditions, a country populated like an ant-hill, with people accustomed to low wages and habituated to indefinite leisure, it becomes not only possible, but necessary, to sacrifice speed and frequency, and luxury, and even comfort, to low fares, and to reduce the fares to rates unheard of in America.

From these somewhat scattering remarks we may perhaps draw the following conclusions. Reducing fares will increase movement, and so will the provision of some attractions at the end of the journey; but the density of population and the wealth of the people come in to modify the matter in a subtle and ever-changing way. Thus the best policy of any given railroad in any given case must be a matter of judgment, based on careful experiment and much observation. It is a repetition of the old story that the judgment of a wise man must always be superior to theories based on general facts.

THE ECONOMICAL USE OF STEAM IN NON-CONDENSING ENGINES.

By James B. Stanwood.

IN America the non-condensing engine is almost universally employed, especially in those districts where fuel is cheap and condensing water is dear. These conditions obtain over a very large portion of the country, particularly in cities and towns. Any improvement, therefore, in the economy of non-condensing engines benefits a large majority of American steam users.

Not very long ago, but before the days of Mr. Corliss, steam pressures of 40 to 60 pounds were in vogue. Plain slide valves cutting off at about three-quarter stroke, or adjustable cut-offs by means of which more expansion was obtained, were generally employed. The speed of the engine was controlled by a butterfly valve operated by a fly-ball governor. The small mean effective pressure, in conjunction with a high pressure of steam at the end of each stroke of the piston (the terminal pressure) caused by a reduction of initial pressure and a low grade of expansion, was absurdly uneconomical. Mr. Corliss, by the invention of the automatic cut-off, radically changed these methods of steam distribution. Steam was admitted to the cylinder with as low initial pressure as 60 pounds, and, with nearly uniform loads, the size of the engine was proportioned so that the cut-off occurred at about one-quarter stroke, and the pressure at the end of the piston stroke was slightly in excess of atmospheric pressure. Under these conditions a maximum mean effective pressure was obtained with a low terminal. This satisfied the conditions existing in factories at that time,—a probable dead load of nearly 50 per cent.

Observe what would have been the result, if these engines had been required to operate for long intervals with one-third or one-quarter load; the cut-off would have been automatically adjusted to one-eighth or one-tenth of the stroke, and with 60 pounds of steam the degree of expansion would have been so great that the terminal pressure at the end of the piston stroke would have been 5 or 6 pounds below atmospheric pressure, reversing the pressure on the piston and causing it to drag like a pump. At the same time the mean effective pressure would have been as low as 8 or 10 pounds—far too small for economical operation.

This high degree of expansion sometimes occurred in Mr. Corliss's practice, especially where engines too large for the work required

were installed ; builder and user were sorely disappointed at the resultant waste, and were at a loss to account for it. It was easily seen that the drag of the piston, due to expansion below the atmosphere at the end of the stroke, accounted for part of it. But should not this have been offset by the high degree of expansion ?

With recent developments in electricity a steam engine driving a generator is the ordinary instrument for deriving energy from coal. In this application light loads and variable loads form a greater proportion of the engine's duty than formerly. For instance, in most factories with mechanical transmission a large portion of the power given out by the engine has gone to drive the transmission machinery, —that is, gearing, shafting, pulleys, and belts. This dead load frequently consumes one-third to two-thirds of the entire power. An engine in such a factory always has a large minimum load. When electrical transmission is employed, the transmission load appears only when work is being done at the motor or lamp, so that the minimum load on the engine is only that due to its own friction together with the resistance of the generator,—usually, in all, not more than 20 per cent. of the rated capacity of the engine. It is seen, therefore, that with electrical transmission the fluctuations in load between maximum and minimum are much greater than with mechanical transmission. On account of a high degree of expansion developed by this prevalence of light loads in this field, it has not been possible to operate engines economically.

Experience has shown that there is a limit to the degree of economical expansion, and this limit has been found to vary with different types of engines. Long-stroke engines were found to have a greater limit, and to be more economical, than short-stroke engines ; short-stroke engines at high speed were more economical than short-stroke engines at slow speed ; engines with small clearance spaces (the waste space between the piston head and cylinder head at end of stroke, including the steam ports) were more economical than those with large clearance spaces. In long-stroke engines the most economical degree of expansion was found to be about four ; in some short-stroke engines it was as low as two. That is to say, in long-stroke engines the economical cut-off should take effect not earlier than one-fifth of the stroke, and in some short-stroke engines not earlier than one-third. Experimental investigations have shown the reasons for this limitation of expansion ; practice and experience have devised methods of extending the limit.

Two serious losses develop with high expansion produced by early cut-offs in single-cylinder engines. The first and most easily discerned is known as the "clearance loss" ; the second and more sub-

tle is the "cylinder condensation loss." It is obvious that, if the clearance spaces have to be filled at each stroke with fresh steam from the boiler, there is a distinct loss, since this steam is thrown away without doing much work. Clearance space in long-stroke engines is ordinarily 3 or 4 per cent., though it has been reduced to about 1 per cent. in special cases. In some short-stroke engines the clearance is 15 or 16 per cent. This accounts for one advantage of long-stroke over short-stroke engines. Wherever clearance spaces are large, they can be partially filled by compressing into them some of the steam left in the cylinder during exhaust; but, as a rule, they give poor economy, as this gain by compression is only slight.

The "cylinder condensation loss," the largest of all the losses, is not generally understood by steam users themselves, although clearly recognized by intelligent engine builders and engineers. The laws which govern it have not been fully ascertained quantitatively, although the manner in which they vary is fairly well understood.

What is this loss?

At each stroke that any engine makes, fresh steam from the boiler meets the surfaces of the steam passages, cylinder head, and piston head, and the cylindrical walls of the cylinder up to cut-off, all of which have previously been cooled by exposure to the low temperature of exhaust steam, and by the abstraction of heat during the period of expansion. These cool surfaces have to be reheated by fresh boiler steam, in order that the cylinder may be habitable for that portion which is to do work. A certain part of this fresh steam is thereby condensed, and becomes a loss, which is called the "cylinder condensation loss."

This amount of cylinder condensation seems to depend upon the amount of condensing surface exposed up to the point that cut-off takes place; upon the difference in temperature between fresh incoming steam and out-going exhaust steam (known as the range of temperature); upon the time which these surfaces have for cooling and reheating (this is regulated by the speed of the engine); and upon the degree of expansion which takes place in the cylinder. The nature of the surfaces, whether smooth or rough, likewise has influence on the amount of condensation. It is difficult in any engine to forecast exactly the amount of cylinder condensation, but in any given engine it appears to be nearly constant at all points of cut-off at any given speed, boiler pressure, and exhaust pressure.

Under these conditions the "cylinder condensation loss" acts very much like a large clearance loss. It is least in long-stroke engines, as they offer less surface for condensation, per volume of steam used; it is most in short-stroke engines, for the opposite reason.

High-speed short-stroke engines are an improvement upon slower short-stroke engines, as the time for condensation is less. In an ordinary long-stroke Corliss engine, working with either early or late cut-off, about 7½ per cent. of a volume of steam equal to the cylinder-full at boiler pressure is condensed to keep the cylinder hot.

If 2 per cent. of the steam is thrown away as a clearance loss and 7½ per cent. as a cylinder condensation loss, the total loss is 9½ per cent. This loss is relatively much larger when steam is admitted for only one-sixth or one-fourth stroke than when it follows the piston for one-third or two-thirds stroke. Therefore the losses, together with the drag of piston on account of expansion below the atmosphere, are much greater with early cut-offs than with late, and the economical limit to expansion is reached when the gain due to expansion is neutralized by this increasing loss of clearance and cylinder condensation and "drag." It is thus easily seen that large engines with light loads, or engines which work under great variation of loads, must operate at early cutoff, and under three very disadvantageous conditions,—to wit, with heavy clearance loss, with cylinder condensation losses, and with a positive resistance developed in the cylinder by the dragging of the piston against atmospheric pressure.

Since the days of Mr. Corliss, steam pressures have continued to increase; this increase of pressure has intensified, in single-cylinder engines, clearance and cylinder-condensation losses. The absolute clearance loss is increased, because the clearance spaces have to be filled by steam at higher pressure, which weighs more per cubic foot than steam at lower pressure. The absolute cylinder condensation loss is increased, because the difference in temperature between fresh incoming steam and outgoing exhaust steam (range of temperature) is increased. For example, the temperature of steam at 60 pounds pressure is 307° F., while the temperature of steam at atmospheric pressure, at which it exhausts, is 212° F.,—a difference of 95° F. The temperature of steam at 100 pounds pressure is 338° F., making a difference of 126° F.; and this increase of temperature-range condenses a greater amount of fresh boiler steam (which is another way of stating that cylinder condensation is increased).

The increase of pressure, however, has reduced the loss due to the dragging of the piston against atmospheric pressure in single-cylinder engines. With a given maximum cut-off, the ratio between the minimum mean effective pressure (that can be secured without expansion below the atmosphere) and the maximum mean effective pressure becomes greater, so that a lighter load in proportion to maximum load can be carried than with lower boiler pressure.

The clearance and condensation losses tend to prevent a gain in

economy with high-pressure steam. To secure this gain, which was theoretically possible, engineers were compelled to abandon the plan of using steam in one cylinder only, experience having proved that higher degrees of expansion with less loss can be secured by expansion through two or more cylinders. A knowledge of these facts was obtained by experience in marine practice, where many practical advantages were secured, besides economy of fuel by the use of multi-cylinder expansion engines.

The success in this field of engineering naturally attracted the attention of steam users and builders of stationary engines. Manufacturers of automatic cut-off engines began to compound their engines. When condensers were employed with these newly-arranged engines, a very satisfactory saving was effected, but, when these engines were built for non-condensing service, the result was a positive failure, except in a few rare instances, where the load was nearly constant and the engine properly proportioned and designed for that load.

Unless the amount of power required is so great, and the change in the load so gradual, that a number of units can always be kept in service with nearly a full load upon each unit, the compound-non-condensing automatic cut-off engine is ill-adapted for electrical plants in which there is a great variation between light and full load.

The conditions that have caused the failure of this type of engine under varying loads are the same that have caused the failure of single-cylinder automatic-cut-off engines similarly loaded. Before considering them, it is well to state the different methods of distributing steam in these compound engines. There are two distinct methods of distribution: first, where the valve or valves of the high-pressure cylinder are under control of the governor; second, where the valve or valves of both cylinders are under control of the governor. Another dual classification can be made by grouping those engines in which the admission valves are under control of the governor, and those in which both admission and exhaust valves are under this control.

With light loads, the loss due to expansion below the atmosphere is greater than in simple engines, as this loss develops in the low-pressure cylinder, which has a large area and gives a great resistance. Frequently the low-pressure cylinder is converted into a pump, which has to be dragged along by the high-pressure cylinder. As boiler pressures increase, this difficulty is not lessened, because the minimum mean effective pressure that can be obtained without expansion below the atmospheric line increases with the boiler pressure, and at about the same rate as the maximum mean effective pressure, so that the ratio of minimum to maximum mean effective pressure is not reduced for light and heavy loads, as is the case in simple engines. In engines

in which valves of both cylinders are under control of the governor, this drag develops in the high-pressure cylinder whenever its terminal pressure falls below the high receiver pressure induced by early cut-off on the low-pressure cylinder.

When the governor controls both the steam and exhaust valves on both cylinders, and the load is light, it is necessary to employ enormously large clearance spaces, into which the steam imprisoned by early compression can be compressed without overstraining the engine. The effect of these large clearance spaces is to maintain a very high terminal pressure in each cylinder, which, with light loads, greatly reduces the chance for the "drag," but, with heavy loads, greatly increases the loss from clearance. In fact, these engines operate with only moderate degrees of expansion, considering the neutralizing effect of their large clearance.

By proper treatment of compression, clearance losses can be greatly reduced in compound engines. This is the case in engines in which the governor controls only the admission valves of both cylinders. By proper adjustment of these valves the receiver pressure can be kept nearly constant; with small clearance spaces and a fixed compression, the clearance losses can be kept very small, and become excessive only with very early cut-offs. But, in an engine in which the governor controls the valves of the high-pressure cylinder only, this loss is greatly augmented at light loads, because the high degree of expansion caused by an early cut-off gives a low receiver pressure, and the clearance spaces have to be filled at every stroke with a low back pressure by steam at boiler pressure.

The chief economical advantage of compounding is to reduce the cylinder condensation loss. We have already seen that the difference in temperature between 100 pounds steam pressure and atmospheric pressure is 126° F. This difference amounts to 154° for 150 pounds pressure, and 169° for 200 pounds pressure. By expanding steam through two or more cylinders, this temperature range can be reduced to ½, ⅓, etc., according to the number of cylinders used, provided, however, that the expansion is properly divided in each cylinder. By reducing this temperature range a great reduction can be effected in the cylinder condensation loss.

We have seen that cylinder condensation in a simple engine is proportionately less at a late cut-off than at an early cut-off. This holds true in compound engines; but, whereas, in the simple engine, the late cut-off is uneconomical on account of the low degree of expansion, it becomes economical in the compound engine, as a high degree of expansion is obtained, and at the same time it is unhampered by excessive cylinder condensation.

Under these considerations it can be seen that, in an engine in which the steam distribution is controlled by varying the cut-off, and in which light loads are developed by means of early cut-off, it must follow that these early cut-offs induce increase of cylinder condensation losses (and clearance losses), and in that way completely neutralize the object of the compounding.

These are the reasons which render compound non-condensing automatic cut-off engines a failure for variable loads. They can be successfully employed, as we have stated before, only when the load is uniform and the engine properly proportioned for that load.

The mistake of engineers and designers is in assuming that the average automatic expansion gears upon which they have bestowed so much care and attention are suitable for the proper distribution of steam in a non-condensing compound engine. Some of these gears may possess superior advantages for regulation and high speeds, but their advocacy stands in the way of economy and intelligent development of the steam engine. With their use higher pressures cannot be employed, and they are unsuitable for the more moderate pressures now in vogue.

From the foregoing it appears that automatic expansion gears applied to non-condensing compound engines are inadequate for the proper distribution of steam for varying loads. Mr. Charles T. Porter, the celebrated American engineer, in a paper presented to the American Society of Mechanical Engineers in 1894, said: "It is clear that, if the variable cut-off had not been already in common use, nothing so unsuitable would have been devised for this purpose." He also said: "It has appeared to me that an opening presented itself for a large improvement in the direction of economy, by employing a fixed point of cut-off, suitably selected, and regulating by means of a throttling governor."

The writer believes that, where the load is variable, the employment of a throttling governor with a fixed point of cut-off as a method of distributing steam in non-condensing multi-cylinder engines will lead to a satisfactory solution of this rather intricate problem.

In another paper the advantages and disadvantages of such a system of distribution will be set forth. Here it is necessary to state only that this system has been extensively developed in connection with vertical engines in England, directly connected to bi-polar electric generators, and operated at speeds as great as 400 or 500 revolutions per minute. The success of the system is largely due to the efforts of the late Mr. Willans, who was led, after years of experimenting, to select the throttle as an instrument by which to control the well-known high-speed engine bearing his name.

EUROPEAN SEA-GOING DREDGES AND DEEP-WATER DREDGING.

By E. L. Corthell.

II.—CONDITIONS JUSTIFYING DREDGING, AND THE RESULTANT COMMERCIAL BENEFITS.

THE exhibition of types of dredges and the analysis of the costs of dredging, which formed the basis of the article in the April number of THE ENGINEERING MAGAZINE, established the position that the apparatus is now so efficient and the expense so low that dredging is a reasonable resort for channel and harbor deepening and maintenance. It remains to consider the physical, economical, and commercial conditions which must be recognized as essential factors in the problem.

The situations where dredging is generally successful are: (*a*) At mouths of rivers with a strong fluvial flow confined by jetties. One of the most notable instances is the mouth of the Mississippi, where for twenty years a deep channel has been maintained by jetties, with occasional resort to dredging to preserve the required channel section, and where, in the formation of the channel, dredging hastened the enlargement.

At the mouth of the Brazos river, Texas, where at times there is a strong river flow succeeded by long periods of low water and with small tidal rise, the silt thrown out by the river floods into the sea tends to form a temporary obstruction there, requiring sometimes weeks for its removal by the action of sea waves and currents. The navigable depth constantly maintainable with complete and consolidated works is about twenty feet. If a suitable dredger were at hand to assist when required, a greater depth could be maintained, and there would certainly never be less than twenty feet under any possible conditions.

The Panuco river at Tampico, Mexico, is subject to great floods at long intervals, due to great rainfalls alternating with absence of rain for months and possibly years. The jetties at the mouth of the river maintain a deep channel, but a suitable dredger, like the "Octopus," would maintain a deeper one. The deposits made in the sea in times of flood would speedily be removed; any tendency to shoal in the jetty channel during the long intervals of low water would quickly be overcome.

A valuable lesson for such conditions as those at the Brazos and Tampico may be learned from the very satisfactory work done by the

COMBINED BUCKET AND SAND-PUMP HOPPER DREDGE "PERCY SANDERSON."
220x14x17 ft.; hopper capacity, 25,180 cu. ft.; lifting capacity per hour, in free soil, pump, 10,750 cu ft., buckets, 20,900 cu. ft.; maximum depth dredged, 35 ft.
Built by Wm. Simons & Co., Ltd., Renfrew.

Percy Sanderson, a combined bucket and sand pump hopper dredger (see photograph), at the Sulina jetties at the mouth of the Danube. About 20½ feet had been maintained there by the works alone for many years, without any resort to dredging; but, as the success of the works and the maintenance of this channel were bringing larger and larger vessels to the harbor, it became desirable to deepen the entrance channel to the navigable depth of 24 feet. The Percy Sanderson was designed and built for the purpose, under the direction of Sir Charles A. Hartley, engineer of the Danube commission. This dredger moves about 300,000 cubic yards per annum from the jetty channel and the sea approach, and maintains the desired navigable depth of 24 feet, with generally a sounded depth of 26 feet. The entire cost of securing this great commercial advantage is not more than £8,000 per annum. The works have not been extended.

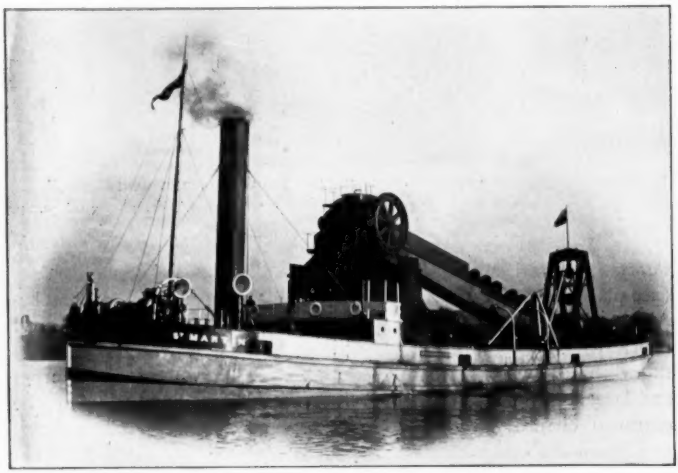
The value of even a few extra reliable inches of water for vessels is often so great that all works designed for the mouths of sedimentary rivers like those above referred to should contemplate, for the construction and maintenance of the channel-way, a first-class powerful dredger suited to the material to be dealt with.

(*b*) Openings into bays and estuaries which have a good tidal rise and flow. Where this tidal flow is confined to the entrance channel, as at Dublin and Tynemouth, occasional dredging will ensure the maintenance of a deep channel; and it is often the case that it can be

almost entirely dispensed with, to be called into use only when storms and a run of heavy sea for some days have thrown sands into the mouths of the jetties or breakwaters.

(*c*) Where works cannot be built, except at enormous expense, the sea bars being so far from the land that a contraction of the tidal flow cannot be made by any constructions. If a channel can be marked out that will be parallel to the tidal flow, particularly the ebb, a dredged channel can be made and maintained.

The most striking example of such conditions is at Liverpool. The sea bar of the Mersey estuary is eleven miles from the land. For



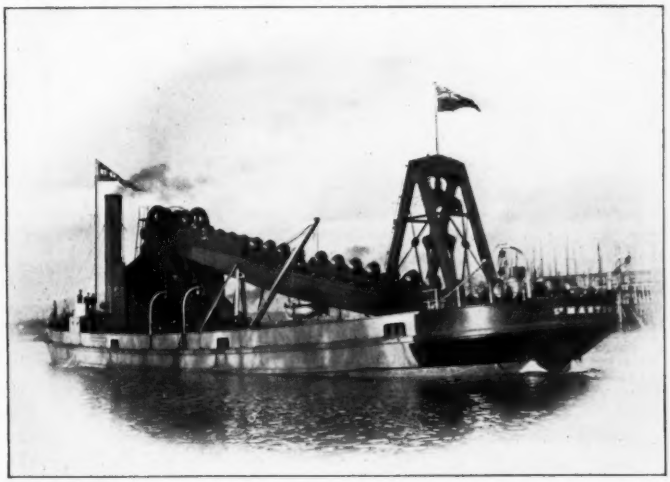
TWIN-SCREW HOPPER DREDGE "ST. MARTIN."

188x38x15½ ft.; hopper capacity, 700 tons; maximum dredging depth, 45 ft.; speed 9 knots. Built for the British Admiralty by Lobnitz & Co., Renfrew, 1894.

many years it was thought to be necessary to reach it in some way by works, but no plan could be devised that would justify the great expenditure required. There was a depth of only 10 feet over this bar at low tide. The competition with other ports, like Southampton, capable of much greater depths, threatened the commercial supremacy of Liverpool. The advance in perfecting and enlarging dredging appliances, and the success in the Gedney's channel, New York harbor, where 30 feet was secured without works by hydraulic dredging, and the necessity of making at Liverpool an equal depth for the steamships that entered New York harbor, compelled the construction of a great dredger that would meet the extraordinary conditions. This dredger and its companion have been described above. With some

smaller dredgers at first used, they have made a channel 1,500 feet wide and more than 26 feet deep at low tide and 57 feet deep at high tide. The channel was carefully laid parallel with the ebb-tide flow, which varies from 2½ to 3 miles per hour. There flows into and out of the Mersey estuary, twice each day, an average volume of 500,000,000 cubic yards of water,—a quantity of moving water beyond the power of the mind to conceive; yet this was made to preserve a depth of 10 to 11 feet on this bar eleven miles out to sea.

Another case of similar conditions, so far as impracticability of works is concerned, is at Gedney's channel, leading into New York



STERN VIEW OF THE "ST. MARTIN." THE "ST. DUNSTAN" IS EXACTLY SIMILAR.

harbor from the sea. This was deepened by hydraulic dredging (sand pumps) to 30 feet depth at mean low water.

(*d*) Where there are no tides and no fluvial flow, but where jetties built into the sea protect a dredged channel from the encroaching sands.

A good illustration of these conditions is the Baltic sea and Zuider zee, at the entrance channels of Lubec, Rostock, Stettin, Danzig, and other ports of Germany and Russia, and at Swolchediep and Ketel-diep on the Zuider zee. The only current force of any use is that produced by the winds; yet for many years channels of considerable depth have been maintained mainly by dredging.

There are conditions on the gulf of Mexico nearly similar to these, where there is a very small tidal range and very insignificant fluvial

BARGE-LOADING BUCKET-DREDGE "LYSTER."
190x35½x13 ft.; lifting capacity per hour, in free soil, 15,900 cu. ft.; Wm. Simons & Co,. Ltd., Renfrew, Scotland.

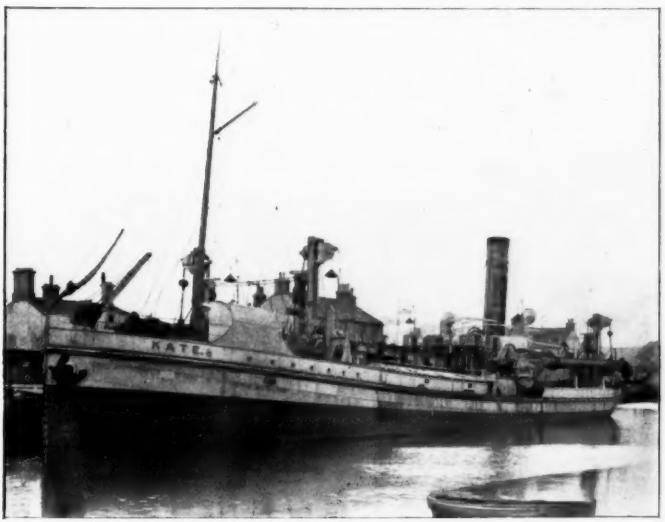
discharge. I refer to Galveston, Aransas Pass, Sabine Pass, and some other less important harbors. At Galveston and Sabine Pass the jetties built into the sea have been supplemented by dredging to great advantage. At the former place the jetties are placed about 1½ miles apart, so that, except under certain abnormal and unusual conditions produced mainly by the winds and storm tides, there is practically no concentration by the tidal flow, and consequently very little force for channel development. The government has set two powerful, especially-constructed suction dredgers at work with efficient results. At Sabine Pass the jetty channel, also wide and with practically no fluvial discharge except at long intervals, has also required dredging to supplement the feeble effects of the works. At Aransas Pass, no doubt, with suitable works, economical dredging by a suction dredger would make and maintain a navigable 26-foot channel. It is proper, in this connection, to state that dynamite dredging has been attempted on this bar, with incomplete works, with some measure of success. And, at Brunswick, Ga., on the South Atlantic coast, where the conditions come under the head of "c", like those at Liverpool and New York, very successful work has been done by this method, with practically no assistance from dredging proper, the only dredging work consisting of smoothing over by rakes and drags the irregular bottom left by large charges of dynamite, which shook up the entire bar and loosened the materials composing it, so that the strong

tidal flow gradually carried them to deeper water outside, where they were dispersed north and south by the currents of the sea and the action of the waves. This interesting and really important engineering work the writer hopes to describe and illustrate at an early date.

(*e*) At the entrances of artificial channels where a great commerce justifies extraordinary expenses.

Ymuiden and Hook of Holland, already referred to, are cases in point. The large tonnage of Amsterdam and Rotterdam makes the annual dredging of more than half a million cubic yards justifiable, when it would be utterly ruinous to smaller ports.

The entrances of Calais, Dunkirk, Ostend, and, in fact, nearly all the North sea ports of France and Belgium, except Antwerp, require constant dredging to maintain the navigation. Winds, waves, and currents are constantly washing the sands into the harbor entrances. The most approved method is to excavate in calm weather a sand reservoir outside the sea ends of the jetties on the side from which the sands mostly come, so that in storms the sands may tumble into this hole, instead of into the entrance channel, blocking navigation. When the storms subside, the excavation is again made. All of these



SAND-PUMP HOPPER DREDGE "KATE."

200x39x14½ ft.; hopper capacity, 20,500 cu. ft.; lifting capacity per hour, in free soil, 30,000 cu. ft.
Wm. Simons & Co., Ltd., Renfrew.

ports are important, and the only way to preserve the integrity of the channel is to dredge. Sluicing or flushing basins, the gates of which are opened at low tide, have been built at great expense at nearly all these ports, but of late years their use has been very limited, as it has been found more economical and much more satisfactory to dredge, especially as the flushing has a tendency to deepen the channel in the vicinity of the basins, but to deposit the excavated material either inside the jetties or just outside in the channel-way, this deposit taking place by the slacking of the flushing current, which cannot carry its load to the point desired in the deep water of the sea in front of the works.

(*f*) Deepening river-channels and excavating canals, as in the case of the Clyde from Glasgow to the sea; of the Tyne from above Newcastle to the sea; of the Tees; of the Weiser; of the Sulina branch of the Danube (100 miles from Braila to the Black sea); of ship canals everywhere; of river improvements like those on the lower Danube; and of hundreds of other important commercial undertakings for the benefit of commerce.

Conversely, the conditions of failure in dredging have been:

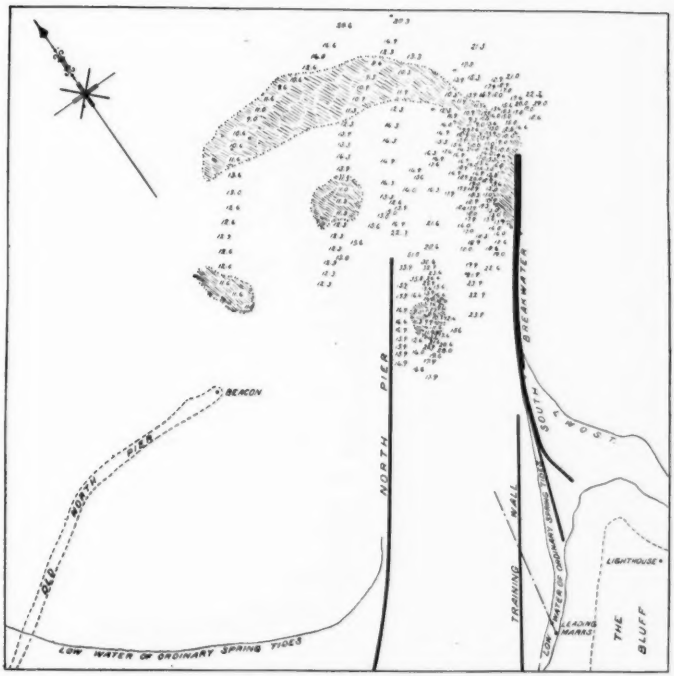
(*a*) Where the depositing action has made the cost of dredging too great for the commerce to be benefited.

The maintenance of the harbors on the North sea, mentioned above, would, with less commerce, be entirely unjustified; and the questions (often delicate and subtle) as to results of projected works in inducing deposits of sand should be carefully weighed before embarking upon the construction of works on sandy coasts.

(*b*) Where jetties or breakwaters would so injuriously disturb the regimen of littoral, tidal, and wind currents, and waves, carrying *débris*, as to silt up the harbors.

The building of a breakwater at St. Catherines, on the Island of Jersey, developed injurious shoaling behind it by its disturbance of the normal conditions of the sea currents. It intercepted these sand-laden currents, and induced extensive deposits, leading to the abandonment of the harbor.

The disturbance of the normal conditions by building jetties and a breakwater in front, thus forming a protected harbor, but intercepting the current movements and the passage of sands along the coast, would be likely to lead to great disappointment and the abandonment of the harbor, or to an extraordinary amount of dredging to prevent the area from silting up completely. An added disadvantage and danger exists where rivers, the waters of which are often charged with sedimentary matters,—washings of the country,—empty into the trap formed by the proposed breakwater lying in front. Such plans have always failed to



HYDROGRAPHIC CHART, PORT OF DURBAN, NATAL.

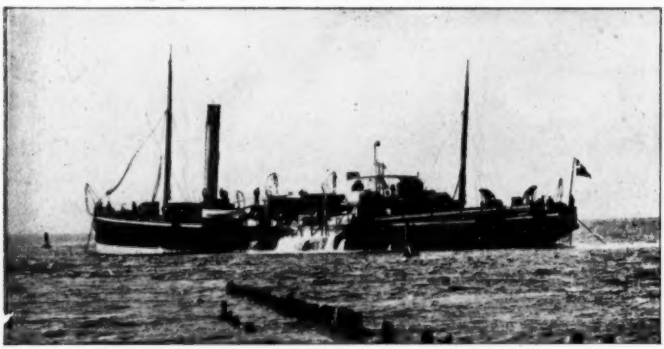
Soundings show location of bar before dredging. Shaded portions indicate less than 12 feet of water. The dredge "Octopus" removed 77,700 tons of sand in the month of November, 1897, and at no point is there now less than 18 feet depth. This dredging also removed much sand from the bight from which the bar was formed, so that heavy storms have as yet caused no perceptible formation of a new bar.

produce commercial harbors. The vast amount of moving sands on almost any sandy coast is not appreciated, until such works develop them by arresting their movement.

SOME INSTANCES OF THE COMMERCIAL BENEFITS OF DREDGING.

Illustrations can only emphasize the fact, patent to every one who makes an examination of harbor and river and canal improvement in many countries, that dredging of navigation channels stands next to the railway as a factor in the commercial development of the civilized world during the last half century. Transportation by sea is accepted as the cheapest means of carrying goods, as well as the most convenient

method of handling large volumes of traffic. It follows, therefore, that estuaries and rivers should be improved, in order to extend the sea traffic as far inland as possible. It may also be noticed that there are very few natural harbors in the world. They are either cut into the solid land, like that of Antwerp and nearly all the harbors of the North sea coast, or they are many miles from the sea, on what were formerly insignificant streams. Within a hundred years there was a depth of only 15 inches at low water in the Clyde at Glasgow, and, 10 miles below, only 2 feet. Newcastle, Hamburg, all the Baltic seaports, are far inland. All this commercial development has been performed by dredging. Wonderful also is the immense amount of work

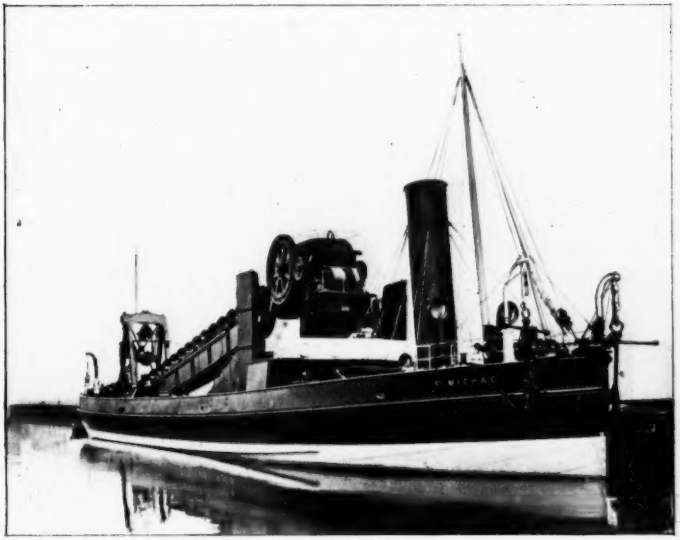


A SAND-PUMP HOPPER DREDGE AT WORK.
Built by Lobnitz & Co., Renfrew.

done by dredges to open up the great interiors of France, Belgium, Holland, Germany, and Russia, making net-works for canals and canalized rivers, and establishing seaports farther and farther inland. Brussels is to become a seaport; so is Berlin; so is ancient Bruges, from whose lofty belfry you can see the dredges cutting a ship canal to Heist and the North sea harbor, now under construction.

Recently the writer, at Budapest, a far inland city, examined the well-considered plans of a harbor with all the facilities of an ocean harbor,—docks (wet and dry), piers, warehouses, and electric cranes. This is for the great barges of the Danube, carrying 1,000 to 1,500 tons. Even Switzerland is to be connected with the Mediterranean and the North sea and Zuider zee, making a harbor at Basel connecting with the Rhone and Main and Rhine navigations of France, Germany, and the Low countries. All this work is done by dredges.

As the dredging appliances improve in economy and capacity, the more extensive will be the improvements for navigation; what could not be done fifty years ago can now be done with ease.



HOPPER AND BARGE-LOADING DREDGE "ST. MICHAEL."

180x36x15½ ft.; hopper capacity, 12,600 cu. ft.; lifting capacity per hour, in free soil, 9,500 cu. ft. Wm. Simons & Co., Ltd., Renfrew.

It may be stated as a general rule that, the greater the facilities for navigation, the greater will be the tonnage of ports, and their business and population.

The most pronounced commercial and industrial results of dredging are seen at Glasgow. A lesson may well be learned from the great and continued success there, to be used elsewhere in the world, and where generally the original conditions are much less difficult. The extraordinary physical changes made by dredging will be seen from the fact that in 1755 only small vessels, or "flats," with a draft of 3 feet or less, could reach Glasgow at *high water* of *spring tides*, while now vessels drawing 27 feet come up on a single tide. Some remarkable physical hydraulic results accompany the deepening of river channels. The tidal flow moves with greater ease in deeper channels. Some of these results at Glasgow may be mentioned, simply as illustrations of what has occurred in many other rivers improved by dredging, though perhaps generally to a less extent. Since 1755 the level of low water at Glasgow has fallen about 8 feet, but the average level of high water has not altered. At present it is about 15 inches higher

TABLE NO. IV.

Statement showing the Progress of Glasgow Harbor, and Docks, Tonnage, etc., of Vessels, Revenue of Clyde Trust, Customs Revenue at Glasgow, and Population of the City of Glasgow; from 1801 to 1897.

DATE.	Glasgow Harbor and Docks.				Vessels Arrived			Tonnage of Goods Imported and Exported.	Clyde Trust Revenue.	Customs Revenue Collected at Glasgow.	Population of the City of Glasgow.
	Lengths of Quays.	Water Area.	Average Depth at Ordinary High Water.		Numbers of Steam and Sailing Vessels.	Maximum Draft.	Tonnage of Vessels.				
	lineal yds.	acres.	ft.	in.		ft. in.	Tons.	Tons.	£ s. d.	£ s. d	
1801.....	382	4	..	.	.....	....	.....	.....	3,400 10 0	427 0 0	77,385
1811.....	697	7	..	.	.....	....	.....	.....	4,755 3 8	3,124 0 0	100,749
1821.....	697	7	..	.	.....	....	.....	.....	8,070 2 2	16,147 0 0	147,043
1831.....	1,543	14	14	6	.....	....	.....	.....	18,932 0 7	68,741 0 0	202,426
1841.....	1,973	23	18	6	.....	....	.....	.....	49,665 15 7	526,100 0 0	255,150
1851.....	3,591	51	20	0	17,274	18 0	1,446,606	1,023,216	68,875 4 9	675,044 0 0	329,096
1861.....	4,376	70	22	0	16,085	20 0	1,504,220	1,366,327	105,768 11 0	924,445 0 0	395,503
1871.....	5,604	75½	23	0	15,800	22 0	2,049,708	1,986,194	164,188 18 7	850,256 0 0	477,732
1881.....	8,422	140	24	0	17,763	23 0	3,057,533	3,053,113	248,061 14 0	1,035,941 0 0	511,415
1891.....	10,753	160½	27	0	16,135	25 6	3,375,109	4,477,506	354,580 11 8	1,391,789 0 0	564,975
1897.....	13,692	205¾	27	0	16,440	27 0	4,082,052	5,673,152	410,190 9 (	1,668,072 0 0	715,579*

* Population within the extended municipal boundary in June, 1897.

at Glasgow than at Greenock, about 22 miles below. Formerly some of the river streets at Glasgow were often flooded during land "freshets." Now, due to straightening, deepening, and widening of the river, flooding never occurs. There is now in Glasgow harbor an extreme range of tide, due partly to winds, of 22 feet. The most marked results are seen in the tidal movements. In 1755 the rise of the tide at Glasgow was only about 2 feet 5 inches. In 1840 spring tides rose 7 feet and neap tides 4 feet 6 inches, while now springs rise 11 feet 4 inches and neaps 8 feet 11 inches. In 1840 the time of high water at Glasgow was 1 hour and 20 minutes later than at Port Glasgow (19½ miles down the river and the limit of the Clyde trustees' jurisdiction); now it is only one hour. In 1840 the duration of flood tide at Glasgow was 4 hours 30 minutes; now it is 5 hours 55 minutes. The ebb tide was 8 hours; now it is 6 hours 24 minutes.

Another indication of the remarkable change caused by dredging is seen in two float experiments, one in the summer of 1853, when a float put into the river at the beginning of ebb took 43½ tides to reach Port Glasgow, while in 1881 a float, under exactly similar conditions, reached Fort Matilda below Greenock, a distance of 23½ miles, in 7 tides.

Previous to 1844 there was no continuous record of quantities dredged; but, since that date up to June 30, 1897, the entire amount of material lifted and carried away from the river and the harbor and docks at Glasgow was 50,721,710 cubic yards. What have been the commercial results? Mr. James Deas, engineer of the Clyde navigation, who has kindly furnished the writer the data from which the above information was taken, has been good enough to furnish a valuable tabulated statement in answer to the writer's inquiries. This statement, which is given in Table IV, on the opposite page, shows the relations between the Clyde Trust Customs revenue, and population of the city of Glasgow during the period between 1801 and 1897.

It will be seen that most gratifying results have attended the dredging of the river and the harbor and docks at Glasgow. The total tonnage of vessels increased, between 1851 and 1897, 200 per cent.; the tonnage of goods, 450 per cent.; the revenue of the Clyde trustees, 500 per cent.; the customs revenue, 150 per cent.; and the population, 100 per cent.

In respect to the dredging of the river Tyne, the writer is indebted to Mr. J. Watt Sanderson, the well-known civil engineer, of Newcastle-on-Tyne, for the following valuable and carefully-compiled information, furnished on request:

Extent and cost of improvement of the river Tyne by dredging,

between 1860 and 1896, and effect of the same as shown by the increase of commerce and riverside population from Newcastle to the sea.

	1860. At low water.	1860. At high water.	1896. At low water.	1896. At high water.
Controlling depth of the river between Newcastle and the sea.....	0	12 ft.	20 ft.	35 ft.
	Previous to 1860.		From 1860 to 1896.	
Tonnage of dredging done.....	2,799,500		96,362,136	
Cost of dredging from 1860 to 1896—not including first cost of dredging plant.....	£1,766,639	=	4.4d. per ton.	
	($8,597,349	=	8.8c. per ton.)	
Increase of commerce as measured by:				
1st. Increase of revenue of River Tyne Commission.....	£66,550 ($324,352)		£319,484 ($1,554,769)	
2d. Register tonnage of ships clearing from the port.....	3,120,265 tons.		6,752,252 tons.	
	1861.		1896.	
Increase of riverside population from Newcastle to the sea during 30 years.			(Note: The population for 5 yrs. 1891 to 1896 has been estimated.)	
On north side of river.....	188,923		363,041	
On south side of river.....	104,258		321,847	
	203,181		684,888	

At Rotterdam, the navigation of which has largely been effected by dredging though the Hook of Holland and deepening the Maas, the tonnage has increased from 15,000,000 cubic meters in 1887 to 29,500,000 in 1896,—about 100 per cent.

Antwerp, the facilities of which have been largely furnished by dredging basins in the solid land, has increased its tonnage from about 2,366,000, including inland, coastwise, and maritime, in 1870, to about 9,000,000 in 1896.

The subject is one of great importance, and replete with interest to the engineer. Only the salient features could be stated in the brief space at command. If the writer has been able to draw attention to the subject, show sufficient advantage to commerce, and bring out in some measure the economics of dredging and its very extensive and increasing use, so as to lead to its more extended employment in furnishing commerce with navigation channels and harbor facilities, he will be satisfied with the laborious, but extremely interesting, work of making the examinations and compiling the information.

AMERICAN AND ENGLISH PRACTICE IN ARCHITECTURAL STEEL CONSTRUCTION.

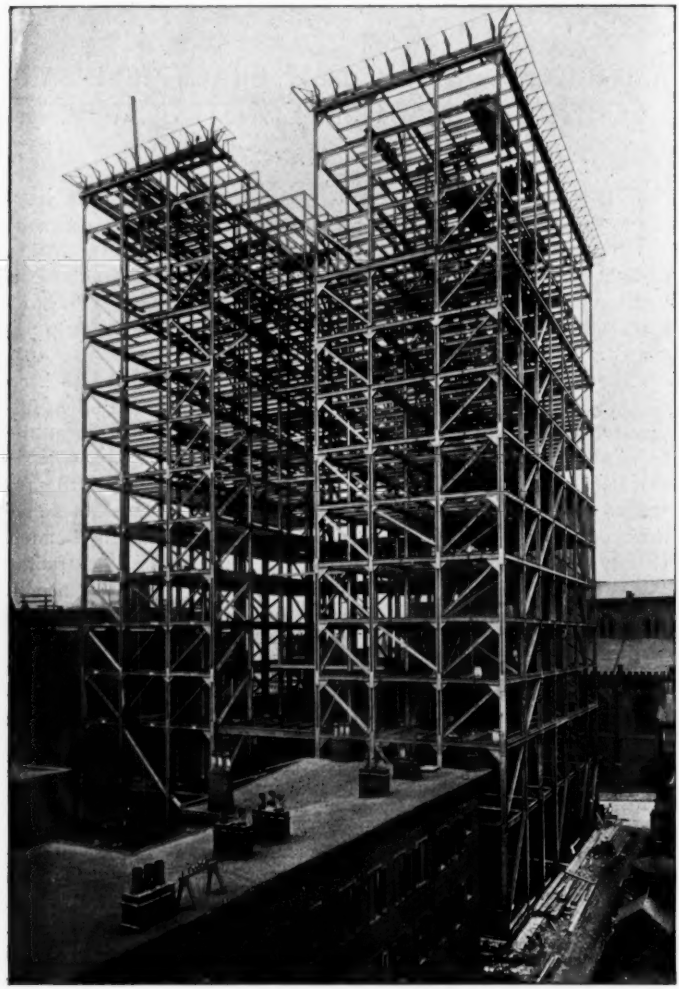
By Charles V. Childs.

TO make a comparison between the English and American practice in architectural steel construction is, to a great extent, equivalent to comparing the present American system to that of eight or ten years ago. Such a statement may be taken to mean that the English methods are that much behind the times; this, however, is not the true explanation; it is rather a case of *autres pays, autres mœurs*.

The architects of the different countries being obliged to keep within the limits of their respective building laws, the restrictions imposed on them naturally affect not only the visible appearance of the building, but also its internal structure. While it is highly probable that but few London buildings would come up to the standard prescribed by the New York building laws,—*i. e.*, inside the so-called fire-limits of New York,—on the other hand it is certain that the London County Council would never permit the erection of the steel-constructed "skyscraper" within the area under its control. As an instance in proof of the former statement, it is necessary only to notice how many of the front walls of London shops are carried on bressummers resting on exposed cast-iron columns. The New York building laws provide that all cast-iron columns supporting outside walls shall be incased in an outer cast-iron shell with an intervening air space, the internal column being sufficiently strong to carry the load.

It is appalling to think what the streets of London, already in so congested a condition, would be like, were it permissible to erect buildings fifteen or twenty stories high. The burning question of New York has long been to provide sufficient rapid transit to and from the business centre of the city; and, while the solution is yet far off, the continual erection of high office-buildings is making matters worse by concentrating business offices within comparatively narrower limits.

The excessive height of the American buildings has necessitated the use of the steel-skeleton construction, in order to economise the weight, and consequently the thickness of the walls in the lower stories, which otherwise would occupy valuable space, to say nothing of the cost of material and labour. The usual thickness of the walls, which, from the nature of the construction, serve only as a covering, is from thirteen and a half to eighteen inches. In England the thickness of

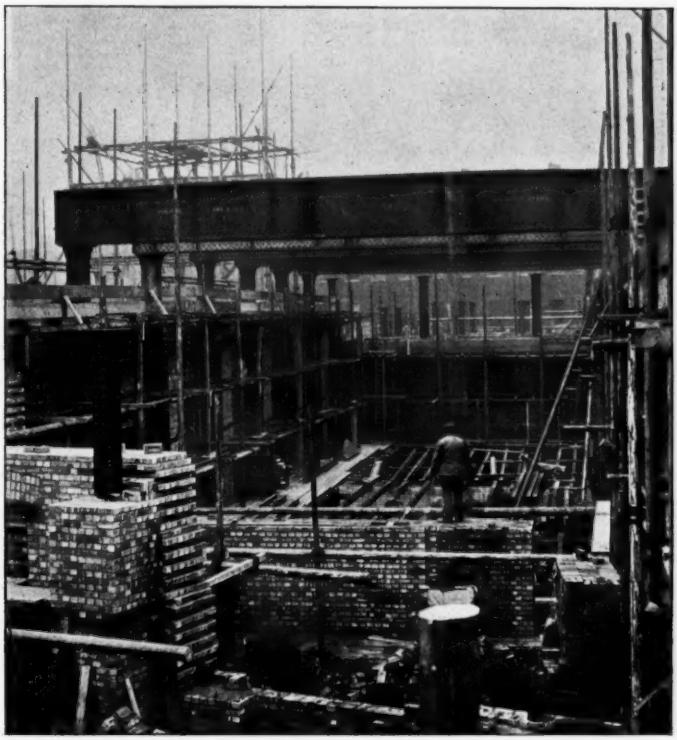


AN AMERICAN TYPE. STEEL FRAME OF THE CARNEGIE BUILDING, PITTSBURG, PA., U.S.A.

wall at the ground-floor-level rarely has to exceed two feet three inches; if, however, instead of being five or six stories, the buildings were to be three or four times that height, the increase in thickness would have

to be enormous, and the steel skeleton framework would probably come into general use.

The steel construction, therefore, has to adapt itself to the style of building prevailing in the different countries. The essential difference, broadly speaking, is that, whereas in American construction each story is supported entirely by girders at the floor-level of that story,



FRAMEWORK FOR THE HOTEL RUSSELL, LONDON, SHOWING THE 15-TON GIRDERS.

and the weight directly transmitted to the foundations by means of the steel columns (Anglicé stanchions), the usual English practice is to place all necessary bressummers at the level of the first floor; these, therefore, having to carry the whole weight of the building above this level, are necessarily heavy compound or plate girders. The accom-

panying illustrations,—one of the Carnegie Steel Co.'s office-building at Pittsburg and the other of the Hotel Russell, London, for each of which the steel work was designed by the writer,—show this difference very clearly. Certain of the American features might be introduced into the English buildings with advantage; the difficulty of

STEEL FRAME, PARTLY ERECTED, FOR THE BOVRIL COMPANY'S BUILDING, LONDON.

doing so lies in the fact that the architect's plans are practically complete before the engineer's work begins.

In order to compare the details of the two systems, it will be well to give a description of the American practice, and call attention to its difference from the English practice.

The steel work in an American building begins a few inches above the foundations, and consists of layers of steel beams, embedded in

concrete, to form the piers, on which the steel bases of the columns rest. The bottom layer is so designed that the load is distributed to the ground at an allowable pressure of two or three tons per square foot; this pressure being the same for all piers, any settlement would be uniform throughout the building. In the next layer the beams rest on those below, at right angles to them, and their length is equal to the breadth of the lower layer. The ends of the beams of each successive layer project, and act as cantilevers, their sizes being determined by the intensity of pressure on their cantilever ends. Anchor rods are embedded in the concrete, and bolt the column bases to the flanges of the uppermost layer. By this method the height of the pier is considerably lessened, effecting a saving in excavation and concrete. The tops of the piers are kept just below the basement floor-level, in order to economise room. The English architect depends on concrete alone for his foundations, and, where buildings have been pulled down, utilises the old bricks for this purpose.

In America the space under the sidewalks, being the property of the owner of the adjoining building, is part of the basement floor. The outside walls are carried on lintels just below the sidewalk-level; as each floor is carried on girders independently of the other floors, these lintels have to support only the weight of the ground-floor walls and probably a portion of the ground-floor load. Where the columns carry party walls, it frequently happens that there is not sufficient space inside the building line to allow the column bases to rest fairly on the piers; in such cases the piers are built inside the party line, and the bases of the columns rest on strong cantilever girders bearing on the piers, the other ends of the girders being either counterbalanced by the internal columns or anchored down to a mass of concrete.

In English buildings, on the other hand, the stanchions carrying bressummers usually rest on blue brick piers, built up to within a foot of the ground-floor-level, and the bases of the stanchions are bolted to York stone plinths. Frequently a sheet of lead is laid between the steel base and the stone. Mention is made of this, because experiments have shown that the practice is harmful; the crushing strength of the stone is thereby diminished, the supposition being that the lead flows into any unevenness in the stone, and acts as a wedge.

The columns in American practice are two stories in height, and the connections are made to break joint alternately at each floor. All connections of columns to columns, girders to columns, and cross-joists to girders are riveted, the riveting gang following after the erection gang, and carefully plumbing each column before riveting

it to the one below. The steel skeleton is thus as much a structure in itself as in the case of a bridge. The London building laws read as follows: "At each end of every metallic bressummer a space shall be left equal to one-quarter of an inch for every ten feet, and also for every fractional part of ten feet of the length of such bressummer, to allow for expansion." Consequently, where bressummers rest on stanchions built into brick piers, slotted holes have to be provided for the bolts.

This theory of expansion, however, is sometimes carried to lengths so extreme that the anchorage of the outside walls to the rest of the building has in some cases been sacrificed; in buildings, especially where the outside walls are carried on bressummers at the first-floor-level, this is of far greater importance than is provision for expansion. If expansion were to take place to the extent allowed for as above, serious cracks would undoubtedly show in the brickwork. The facts that bricks also expand to a limited extent, and that the steel work is, in almost all cases, protected from the outside temperature, should be taken into consideration; the friction between the steel and the brickwork probably equalises their difference of expansion.

The question of wind-bracing does not enter into the English construction, but is an important factor in American high buildings. In the illustration of the Carnegie building it will be noticed that gusset plates are used; the diagonal struts shown are merely temporary timbers, to prevent any possible distortion until the brickwork is built. The usual practice, however, is to connect four columns with lateral bracing, so as to form a tower extending from the bottom to the top of the building. It is questionable whether there is sufficient stiffness, or breadth of base, for this to be of any practical use. In calculating the strains due to wind pressure, the building itself may be considered as a cantilever; the columns in the outside walls, therefore, should be sufficiently strengthened to take up what would correspond to the flange strains in a girder; and, no doubt, the brickwork of the outside walls acts as the web, or counteracts the shear. The brickwork, therefore, should be carefully built round the steel work, and be of sufficient strength to withstand the diagonal pressure, or, in other words, the tendency to distortion which is caused by the shear.

The almost universal practice in America is to space the floor beams six feet apart, and to brace them with rows of ¾-inch tie rods; the space between the beams is then filled in with hollow flat arches, made of firebrick. It is usual in England to space the cross-joists two or three feet apart, and fill in solid with concrete; or, in

order to economise weight and the trouble of centreing, to use one of the many patented floor constructions. The method of connecting the cross joists to the girders depends on the distance between the cross joists. If this spacing is only two or three feet, it is more economical to rivet a continuous shelf angle to the web of the girder; this forms a bearing for the cross joists, and also a support to the concrete filling. Where the cross joists are spaced farther apart, it is more economical to rivet them separately to the girders by means of connection angles.

Slight differences, or, rather, preferences, prevail in regard to the cross sections generally in use for joists, girders, or stanchions, but these are not very pronounced. The English sections of steel joists are, in most cases, heavier than American ones of equal depth. In designing the girders for a floor, provided there were no limitations as regards their depth, American sections would be found somewhat more economical in weight than if English ones were used. If the depth of the girders were limited, as is usually the case, this difference would probably vanish. On the other hand, the English sections, being wider in the flanges, are better adapted to use for rivetted girders, and stanchions. As regards larger girders, compounds (*i. e.*, girders made up of joists and flange plates) are more extensively used in England than in America. This is partly due to the greater concentration of the loads in an English building, requiring heavier girders than are required in an American building, where the girders usually carry the loads of one story only. There also seems to be a preference among English architects for compounds rather than for two or more joists bolted together side by side.

Columns or stanchions vary very much, according to what the manufacturers adopt as their standard sections; as, for example, the Z-bar columns of the Carnegie Steel Company, or the Phœnix Company's columns built up of segmental shapes. In England the sections generally in use are those of a steel joist or joists with plates rivetted to their flanges; or, where the loads are light, of a single steel joist only. Certain joists are specially rolled for this purpose,—*e. g.*, a 9-inch deep joist with 7-inch flanges, weighing 58 pounds per foot, and a 10 by 8 inch joist, 70 pounds per foot. Frequently the joist can be arranged to run through three or four stories, the extra strength in the lower floors being attained by varying the thickness and width of the flange plates, which also may form the splice plates at the joints in the stanchions. These sections are admirably adapted for the connections of the floor joists, and eccentricity of loading is reduced to a minimum; this consideration is really of even greater importance than the arrangement of the metal to give the highest radius of gyration.

Probably, had it not been for the combination among American manufacturers, in the past, to keep up the price of I-beams and channels, these sections would have been more generally adopted by them; but, when the combination was in force, steel columns were displacing cast-iron columns, and, for economic reasons, other sections were adopted, and became, so to speak, stereotyped.

It would occupy too much space to compare all the minor details of construction, but something should be said in regard to the methods of fireproofing. Stone, brick, and steel are not, strictly speaking, fireproof; and, until English architects fully realise this fact and introduce proper fire-resisting material, no building in England will be worthy of the name "fireproof." In America all girders and joists are carefully encased in tiles made of *fireclay*, with an air space, to act as a non-conductor of heat, between the tiles and the steel work. Moreover, the partitions between the rooms and the furring inside the brick walls are of firebrick. The firebrick contract is naturally an expensive item, the estimate for the Carnegie Building amounting to $50,000 for this portion of the work.

English "fireproofing" may withstand a small fire originating inside the building, but is entirely inadequate to resist a large body of heat, such as may be caused by the conflagration of neighbouring buildings, or the combustion of inflammable material stored within the building.

AN EFFECTIVE SYSTEM OF FINDING AND KEEPING SHOP COSTS.

By Henry Roland.

II.—THE COLLECTIVE JOB-TICKET ADAPTED TO A DROP-FORGING WORKS.

THE manufacture of drop forgings, although requiring great ingenuity and skill in devising methods and making the dies which produce those complicated and seemingly impossible forms now made from the solid steel bar by the action of one die falling upon another, is a process involving but few shop-departments; hence drop-forging prime and total costs are easily kept by the collective job-ticket alone, provided a general scheme of cost-keeping of sufficient scope and ingenuity to meet the conditions is made a precedent.

Such a general system has been devised by Mr. Foote, of the firm of Strieby & Foote, Newark, N. J., U. S. A., which began business in a small way in 1879, the founders being two thoroughly experienced men,—one a salesman and the other a drop-forger. The excellent quality of work produced and the good business management have given this establishment uninterrupted success, and for many years it has held an enviable position among American drop-forging makers. It is now employing very nearly its maximum number of hands, and is full of orders. The production was at first almost entirely carriage work, but is now about evenly divided between carriage and bicycle forgings, many of the latter being surprising examples of the art.

Up to 1883 this firm had no thoroughly-formulated system of cost-keeping, and did not know what its actual costs were. The "Beecher rule" for making drop-forging cost-estimates was in force, and Mr. Foote said, in speaking of this simple rule, devised by Beecher, of Meriden, Conn., one of the early American drop forgers, that it gave in average work a wonderfully close approximation to accuracy. Beecher's rule was to add the stock-cost, the weight of the rough stock being one-third more than that of the finished work, and the flat labor-cost, and double the sum of these two items for the selling cost. If the work is of about the average description, the rough and ready Beecher rule gives results very nearly correct, but, if the work is very simple and so uses a large weight of stock for the labor involved, the Beecher rule makes the selling price too high, while with little stock and much labor the price is too low.

When the Strieby & Foote management devolved upon Mr. Foote, he speedily became aware of the urgent need of an accurate knowl-

edge of his prime and total cost, and met this demand by the ingenious and comprehensive system which, through his courtesy, is here laid before the readers of this magazine. Precise information like that given by Mr. Foote in regard to the details of his own highly-successful methods of cost-finding and keeping is of the greatest value to manufacturers at large, and the man who gives it from the certainties of his own thoroughly-tested practice must be regarded as a public benefactor, in highly favorable contrast to those manufacturers who, having cost-keeping systems of their own devising, decline to "give their business methods away," or to "educate the public," forgetting that accurate knowledge of manufacturing costs tends to general prosperity, because it tends to that maintenance of living prices by all which must follow a really accurate knowledge of shop costs. Unquestionably a whole branch of manufacturing trade may be demoralized and rendered unprofitable for a considerable time by the vigorous efforts of two or three rivals, none of whom know what work really costs them, to secure new business. Were these reckless under-bidders aware of the real cost of their own productions, no such condition of affairs could obtain, since it is certain that no manufacturer intends, single-handed, to sell at a loss. Hence it is very clearly to the direct individual interest of every manufacturer who really does employ an efficient cost system to make that system public, because such information educates the public, and so ensures prices under which good management can conduct a prosperous business. It is ignorance, not knowledge, which is to be feared in manufacturing as well as everywhere else and the highest wisdom and most beneficial foresight is to be credited to the really proficient manufacturer who brings his competitors up to his own standard of information.

If a manufacturer had a private system of cost-keeping which was perfect, and which did not cost one cent in operation, even this impossible supposititious condition would not justify him in refusing to "educate the public," because the total expense percentage added by the most cumbersome system of accurate cost-keeping is not sufficient to materially affect selling prices.

In Mr. Foote's system of total cost-finding, charges are divided into groups as follows:

(1) Office charges, including all clerical labor, expenses of commercial travellers, and every outlay connected with the office and selling departments.

(2) Factory charges, including all realty considerations, rent, taxes, insurance, and rise or fall of ground values, as well as superintendent's, foreman's, and helper's, or laborer's, pay, and all factory expenses which are not actual labor on output. This account in-

cludes repairs to machinery, coal for engine which drives the shop, all power expenses, and every other item of outlay other than that for the labor of workmen engaged directly in the production of manufactured output.

(3) Manufacturing account. This includes the day wages or piece-prices paid to the workmen engaged in actual output production, the coal used in heating work, which varies very greatly with different pieces and is an important flat-cost item, and pickling and grinding.

(4) Die-room account, including the wages of the foreman die-maker and the workmen under his charge. No charge is made against the die-room for power or use of machinery.

The total factory expense charges are made up by adding the second and fourth items,—the factory expenses and the tool-room expenses,—and this total expense is apportioned among the work-producing tools on an arbitrary work-producing tool-cost basis. For example, a thousand-pound Billings and Spencer drop hammer, costing $1,200, is apportioned, as its share of daily total expense, $11.80, this sum being obtained by dividing the total of the three expense items specified by the total cost of work-producing tools, thus making each work-producing tool bear a part proportional to its cost. In case a work-producing tool is subject to an unusually large charge for breakage and repairs, its *ad valorem* expense percentage is advanced arbitrarily, and that of some less hardly-worked tool is diminished to make totals balance.

Thus each work-producing tool in the factory has a certain daily weekly or yearly charge standing against it, which it must earn to keep the establishment out of debt. If a tool is idle, it increases its indebtedness by every hour of such idleness, and this indebtedness is cancelled or paid by the profits gained from work produced by other tools which are earning money while the idler is eating its head off.

Nothing could more strongly emphasize the correctness of recognising the floor-production per square foot of shop-floor area as the true unit of industrial success than the per-day charge of $11.80 against the idle 1000-pound hammer.

As used above, the "shop floor" means the area of effort, the theatre of those operations which distinguish a factory from a vacancy. While it may be regarded as correct to speak widely of the "square-foot of floor production" as "the unit of industrial success," it is obvious that no shop accounts can be based upon the square foot of floor-area or some multiple thereof, because, while the shop-floor as a whole supports the whole of the industrial aids and operations which distinguish the factory from waste ground, much of

this floor is not used in actual production of finished product. But the floor supports the work-producing tools, and these tools may be substituted for the floor-area in industrial book-keeping. When this is done, as in Mr. Foote's system of shop-account keeping, the all-including "floor-area" is at once divided into wage-earning or money-losing units, which are perfectly defined, and hence are entirely suitable subjects for accounting. When a tool has its daily indebtedness to the shop correctly fixed, it becomes a very easy matter to ascertain whether the tool is keeping even or falling behind its responsibities.

But the shop economist must be well advanced in true knowledge of factory-production laws before he becomes fully aware that every foot of shop floor, or each tool standing on the shop floor, is under a wage-saving obligation to the shop.

The average shop-foreman, innocent of all knowledge of the actual conditions of shop economy, will say, if his attention is called to the loss entailed by an idle tool, that the loss is trifling. The hammer stands still; it cost $1,200. Its interest cost per day to the shop is therefore (if the year be held to consist of 250 working days) less than half a dollar; an idle hammer requires no power, no coal, no hammerman; it is in no one's way, and it is costing nothing worth talking about. Such would be the average foreman's statement of the case of the idle 1000-pound hammer, and a concurring opinion on the part of the manager has led many a highly respectable non-cost-keeping firm to bankruptcy. The idle tool costs the shop every day all of its proper apportionment of the shop expense which would be its needful earnings if in operation, and, instead of losing its owners a paltry half dollar per day, the idle 1000-pound hammer costs the shop twenty or more times that sum.

This point cannot be too strongly emphasized, or too often repeated, because perhaps a majority of manufacturers fail entirely to recognise the correctness of this proposition.

But this apportionment of expense per dollar of productive tool-cost is manifestly correct. Here is a certain earning which must be made by a certain number of wage-earners to keep the community out of debt. Nothing can be more just than to say that the greater and stronger worker should earn a greater wage than the smaller and weaker workman. That is the verdict of England's late great strike, and a man and a work-producing tool are equivalents in factory economics. Mr. Foote's system is absolutely correct in giving each tool its daily proportion of the expense account. Time evens all things, and the tool which is bankrupt at the end of one idle week may be even at the end of a month of work, and a large earner at the

end of the year, just the same as the flesh-and-blood workman ; and a day lost by either man or machine is a day's wage lost beyond recall.

Having fixed the proportion of expense to be borne by each tool for each of the 250 working days of the average year, Mr. Foote's system is brought up to the point of considering the three items of flat-cost of production, which are as follows :

(1) Material. Actual weight of stock required to make the piece. Ten per cent. more or less is added to stock-cost as a shop charge for interest, storage, and handling.

(2) Piece-price or day wage of the workman who produces the piece.

(3) Coal consumed in heating the work ; actual weight by trial, or estimated weight from record of similar pieces previously made.

These three items make up the flat-cost or prime-cost of the piece. For the total cost the percentage of general expense assessed against the individual tool employed for the time of work-production is added to the flat-cost.

The one arbitrary assumption of this system is that which fixes the individual productive-tool indebtedness to the factory by the cost of the tool itself. Mr. Foote says that the results of the extended trial which has been given this assumption proves its correctness, and it is not easy to find any tenable ground for assailing the proposition. The theory is that a certain value of productive machines must earn enough money to cover the total of the expense charges ; one dollar of this producing-tool value is as good as another dollar, and, on this basis of share and share alike, a tool which costs a thousand dollars should be charged with double the fixed charges on a $500 tool. The higher-priced tool must, therefore, earn more than the lower-priced tool to keep itself out of debt.

Estimating prices of proposed work involves, first, a reference to the sample boards, which are conveniently hinged so as to shut up like doors, and thus give a great display surface without taking up much floor-room, and which, at the present stage of the existence of the Strieby & Foote Company, contain so vast a number and variety of samples of pieces produced as to make it unlikely that a model will be submitted for estimate which has not an approximation in work done before. Each piece of work made has its shop number stamped on it, and painted in conspicuous letters on the board where it hangs, and is indexed so that the job-ticket on which the piece was made can very readily be found. With the job-ticket for the similar piece in hand, the estimate can be given instantly, as the safe piece price of the manufactured article is given on that job-

ticket. Should there be material variations between a submitted model and the nearest approach to it found on the sample boards, the variation would, of course, be noticed by shading the estimate. But it is no exaggeration whatever to say that the manufacturer, by aid of this collective job-ticket record of past production, can tell within a few mills of what the actual total manufacturing cost of any model of drop-forging within the capacity of his hammers will be.

The Strieby & Foote job-ticket is shown below. This job-ticket

Date, *March 20, 1898.*

Article, *1,000 Sprockets, No. 2815.* { No. 3361.

No.	Operation.	No. of Hours.	Drop.	Rate.	Operator.	Amount.
1,000	*Block.*	*9*	*H.*	*40*	*A. Smith.*	*4.00*
1,000	*Blank.*	*10*	"	*50*	"	*5.00*
1,000	*Finished.*	*20*	"	*80*	"	*8.00*
					Coal, 8c.	*3.12*
		39			*2,000 lbs. steel*	*40.00*
						60.12
					39 hours at $1.18	*46.02*
Inspected—					*Punch, 75c.*	*1.50*
1,000 O. K.			*B. Smith*		*2 hrs, at 30c.*	*60*
No N. G.						
						108.24
	Can sell for $15.16 per 100.				*40 per cent.*	*43.29*
						151.53

is "collective" in the widest sense of the term. It gives all shop particulars of manufacture, the coal-cost, stock-cost, labor-cost, tool-cost, and the total cost.

It will be observed that Mr. Foote's system separates the total shop cost from the office charges entirely. His conception is that the office stands in the position of a merchant dealing in finished products only. The wares cost the office so much,—that is to say, the total factory cost. Then to this factory cost the office adds its own expenses and the selling expenses and its profit as a dealer, which gives the total cost, or selling price, viewing the office and factory as parts of the same unit.

The Strieby & Foote collective job-ticket bears, first, the date and order number and name and shop number of the piece. Then comes a line of column-headings, which explains itself. The hammer work, in the example shown, was at piece rates, 40 cents per 100 for blocking out, 50 cents for blanking, and 80 cents for finishing. The coal cost was 8 cents per hour. Two thousand pounds of steel were used,

charged at 2 cents, which was an advance of about 7½ per cent. upon cost at the factory door. This makes a total stock, labor, and coal cost of $60.12 when the hammerman was done. Then the per-hour share of shop expense for the tool, drop hammer "H," $1.18 per hour for 39 hours, = $46.02, is charged. There is a hole punched in each sprocket by B. Smith, who did the work in two hours, at 75 cents per hour, on a press which had a 30 cents per hour charge. These items bring the total shop-cost up to $108.24. Then the office charge of 40 per cent., covering office and selling expenses, is added, making the total cost for the 1,000 pieces $151.53. The middle of the ticket bears the memorandum based on this 1,000 piece cost: "Can sell for $15.16 per 100." The left-hand corner bears the inspector's check of "1,000 O. K. No N. G."

For work in progress the job-tickets stand on edge in a rack of pigeon-holes in the superintendent's office. When a job is done, the ticket and job go to the inspector, and thence to the finished-stores room, the job ticket going to Mr. Foote, who is president and principal stockholder, and is also cost-clerk. Mr. Foote devotes two hours daily to the job-tickets, because these tickets and the information they contain bring him into the closest possible touch with every department of the works. Job-tickets are finally filed and indexed according to the character of the piece. A sprocket order is indexed as "sprocket No.—," not as "order No.—," and filed with all the other sprocket tickets without regard to order number, although of course the latest sprocket order bears the highest job-ticket-number. It is the work of but an instant to compare the per-100 selling cost, or the factory-cost, or stock-cost, or coal-cost, or time-cost in hours required for production of any one sprocket order, with that of another sprocket order, and any notable discrepancy between the cost items of two similar sprockets is at once made a subject for investigation.

Thus this simple collective job-ticket secures to Mr. Foote a permanent and accessible record of all important particulars of every piece of work made in this drop-forging shop. For his personal use Mr. Foote makes up a little book of per-100 prices, but, so far as the permanent shop record is concerned, the collective job-ticket holds everything, and is not tranferred to any shop-book of any kind.

Although it is not strictly within the scope of this article, it is well to say here that piece rates are the rule in this shop, and that, once made, they are never changed. On this point Mr. Foote said: "What I want is a large per-hour production, not a small pay-roll. If I have a profit of one cent on a piece, and a man, by exerting himself, can increase the output by ten pieces per hour, I gain ten cents,

and can afford to pay the workman five cents of the ten, and still do better than if the man earned fifty cents a day less money. I am certain that even now some of my hands do not quite dare to extend themselves, for fear that a cut would follow, in spite of my assurances that I want the greatest possible product and am glad to pay for it. I expect to piece work at prices giving a workman $4.50 per ten hours. If I find I have made a too high piece-rate, I do not reduce it. It is never very much too high. But the next job I piece to that same workman I may rate so that he will have to be industrious to reach the $4.50 rate, and so even things up a bit, without destroying confidence by cutting a fixed rate."

The die room, which is a very important department in a drop-forging establishment, has been mentioned as charged in total as an item of the manufacturing expense. If new dies are needed for an order large enough to cover the life of the dies, this is correct practice. But, if only a small order is called for, then the customer pays for the dies. In this case there is an earning which does not appear on the job-ticket, but simply goes to the profit side of the ledger. As this item of gain is not very large, and is in favor of the establishment, it can safely be neglected on the job-ticket. As a rule, drop dies are not ordered for small lots of work, but pound their lives out and are replaced by others,—in some cases many times.

From this instance of dies made at the customer's cost, it is easy to draw the general conclusion that special cases and conditions should not be recorded on the collective job-ticket. The information given by the job-ticket is to guide general practice, and should not contain special or abnormal items.

Taken all in all, the writer has never seen any other system of cost-keeping so cheap and altogether satisfactory as that just described. It is but just to the writer to say that at the time of writing the first paper of this series, in which the collective job-ticket was treated as a novelty of the writer's own presentation, he was not aware of Mr. Foote's very complete and admirably simple use of the collective job-ticket, nor did he know of its use otherwise. Mr. Foote's collective job-ticket makes it clear that the writer's assumption of originality was founded, as claims to originality often are, on ignorance of the practice of others. While confessing this ignorance, the writer is pleased to find his suppositions in regard to the possibilities of the collective job-ticket so amply sustained by highly successful practice, and practice so simple, so comprehensive, and so cheap that it seems almost an impossibility to improve upon it.

But there are simple manufactures which it seems impossible to cover by the use of the job-ticket.

THE PURIFICATION OF RIVER WATER-SUPPLIES.

By Allen Hazen.

ONE of the most noticeable results of the improved facilities for the transportation of foods and manufactured products is the great concentration of population which has been and is taking place in the larger cities, largely at the expense of the rural population. This concentration of population has resulted in a whole series of municipal questions, upon the successful solution of which depends the future of our civilization.

Among these questions none is more interesting or important, or more directly affects the health, happiness, and welfare of the entire urban population, than that of securing an abundant supply of pure and healthy water.

In the Roman world the importance of pure water was widely recognized, and the remains of the ancient aqueducts are among the noblest monuments of that time. With the disintegration of the Roman empire public water-supplies went out of common use. The conditions did not favor the concentration of population in great cities, and all through the Middle Ages the inhabitants of European cities were dependent largely upon wells for their supplies of water. These wells served as receptacles for much of the filth and liquid waste from the people who used them, and the waters drawn from them were often unhealthy, although this was not realized by the people, who attributed the plague, cholera, and other sicknesses resulting from their use to other causes; and it is probable that wells were finally abandoned not so much because of the badness of the water obtained from them as because of their failure to supply a quantity of water adequate to the demands of increasing population.

When the well supplies in the centers of London, Hamburg, and other cities became inadequate, the first attempts were made at the distribution of water through pipes, which were the beginnings of our modern system of public water-supply. These early public water-supplies were invariably pumped from the nearest river or pond, and from that time until the present the most important sources of water-supplies have been the rivers.

When cities were fewer in number and far less populous than at present, and when sewerage systems were nearly unknown, the pol-

lutions of the rivers were comparatively unimportant, and water-supplies taken from them, even from intakes near the centers of large cities, were less objectionable than the waters from wells previously used; and so the early public water-supplies, bad as they were, were distinct improvements upon previous conditions.

There are many sources of river pollution, but sewers are, in general, more important than all the others combined. Until comparatively recent times many cities had no sewers: even large cities were but incompletely sewered, and large proportions of their populations were dependent upon earth closets or privy vaults, the contents of which were removed from time to time. Such vaults have been, and are, going out of use, and the use of water closets discharging to the sewers has been very greatly extended. Even small cities are now supplied with these conveniences, and the proportion of people connected with the sewers in the larger cities has been much increased.

It thus happens that, while the urban population upon the watersheds of our rivers has greatly increased, the pollution of the rivers resulting from it has increased even more rapidly; and the end is not yet reached, for many cities are still dependent more or less upon privy vaults, which are gradually being abandoned, so that we may expect that for some time yet the pollution of rivers will increase considerably faster than the increase in urban population upon their banks.

River waters have probably been, ever since the time when they were first used, more or less unhealthy, but for a long period this was not clearly recognized. With the increasing pollutions their use caused disease more frequently, until at last their unhealthfulness forced itself upon the attention of the people, and the objections to their use have since constantly become more apparent.

Because of the unhealthfulness of river waters in their raw state, some cities have abandoned their use, and have sought unpolluted water-supplies, oftentimes at great distances. Such supplies have been secured most frequently from impounding reservoirs constructed upon comparatively small and uninhabited or nearly uninhabited watersheds. Other cities have secured water from underground sources, and such water, with proper systems of collection, is almost invariably free from disease-producing qualities, although often harder than surface waters, and sometimes containing iron, which makes it less desirable.

Both impounding reservoirs and underground sources of supply require certain favorable physical and geological conditions. To secure a ground water-supply suitable water-bearing rock or gravel strata must be available; and to get a satisfactory supply from an im-

pounding reservoir a water-shed of sufficient size and nearly free from population must be found, at the outlet of which there must be a suitable reservoir site. If these conditions do not exist, it is useless to think of securing water-supplies in these ways, and the city must continue to use its river supply with such improvements as it may be able to make. Very many of the great cities of the United States are so situated that there is practically no chance of securing ground water-supplies or suitable storage reservoir or lake supplies; these cities must continue to use river waters.

The processes which have been suggested for the purification of river waters are very numerous, but those which have been actually used with success are very few. Practically filtration is the only process successfully employed, and among the types of filters used the type known as the sand filter has been so much more widely and successfully used than any of the others as to give it a unique position.

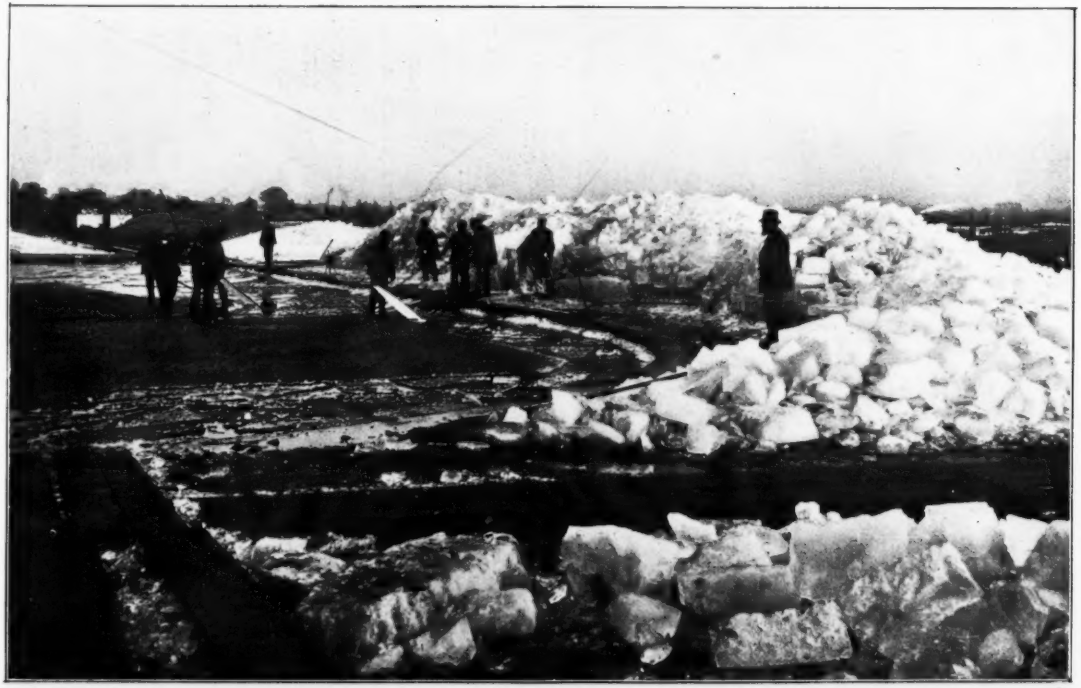
Sand filters for the purification of municipal supplies consist, in general, of rectangular basins with water-tight bottoms and sides, with underdrains upon the bottom surrounded and covered with small stones, upon which rest smaller stones, and then gravel and finer gravel, and finally a deep layer of moderately fine sand, such as is obtained in many places from river-beds, from beaches, and from sand banks. Arrangements are made for taking the river water over the sand, covering it several feet deep. The underdrains are connected with the reservoirs or pumps, and, as water is drawn from them, and by them in turn from the spaces between the stones on the bottom of the filters, its place is taken by water from above, and in this way an extremely slow and steady flow of water downward through the sand is maintained.

In the passage of the water through the sand the suspended matters are removed, and the water flows out below in a clear and palatable condition. The matters removed from the water gradually accumulate in the sand, until its pores become so far filled with them that water will not pass in sufficient quantity to meet the requirements, and it is then necessary to draw the water off from the top of the filter, and to scrape off the upper layer of sand, which contains the greater part of the matters removed from the filtered water. Afterwards water is again taken over the sand, flowing through it as before. Eventually it is necessary to replace the sand which has been removed, to maintain the layer at its full thickness. Such filters are constructed in groups, and each filter is controlled by gates or other regulating apparatus, so that it can be shut off for the purpose of being cleaned, while the supply is maintained uninterruptedly from the others. Sometimes filters are built with earth embankments, having

sloping sides paved with materials to withstand ice and frost action. More frequently masonry walls are used, thus making a neater and more satisfactory, although somewhat more expensive, construction. The bottoms are commonly made water-tight with concrete, although other arrangements are sometimes used; where the natural bottom is exceptionally good and there is no danger of loss of filtered water by seepage, the artificial bottom is omitted.

Where the winters are not too severe, filters are built open to the sky, but farther north, where the frost is severe, it is necessary to cover them as a protection from ice and cold. The simple formation of ice on the surface of water upon a filter does not, in general, materially interfere with its operation, but, when it becomes necessary to clean the filter in very cold weather, the ice must be removed at considerable expense, after which the water is drawn off and the dirty sand removed. If during this operation the surface of the sand layer becomes frozen, even slightly, the results which are obtained from the filter afterwards are inferior to those normally obtained. The reason for this is not yet clearly understood, although it seems to be in large measure due to the killing by frost of the organisms most active in purification. The sand of a filter is filled with living organisms, which live in it and feed upon the matters in the passing water, which are at once their food and the matters which make the water objectionable in its raw state, and the action of a filter depends in considerable measure upon the presence and activity of these organisms. When these organisms are destroyed, accidentally or otherwise, in warm weather, it takes but a short time for other organisms to establish themselves in their places, but at the freezing-point bacterial changes go on much more slowly than at warmer temperatures, and the time required for a filter to recover its normal action is much longer. For these reasons the operation of open filters at northern winter temperatures requires some care and skill, in order to secure at all times the best results, and, where the cold is severe, covered filters are necessary to insure at all times a satisfactory effluent. Filters protected in this way are not influenced by frost, and yield effluents of the full standard of purity throughout the year.

The processes taking place in sand filters are very intricate. They can be separated into two distinct and widely different actions or classes of actions,—namely, (1) mechanical or straining actions, and (2) oxidation or biological changes. These actions always take place simultaneously in sand filtration, but their relative importance varies widely in different cases. In removing the mud and sediment generally present in river waters the straining action is the more important, while many of the organic matters, which include the sub-



REMOVING ICE FROM A FILTER.

The winters of England are not severe, and open filters suffer but little from ice. This photograph of one of the East London filters, taken Feb. 19, 1895, shows the greatest accumulation of ice in the history of the works.

COVERED FILTER IN COURSE OF CONSTRUCTION.
Showing wooden centres for masonry vaulting. (Somersworth, N. H.)

stances that cause tastes and odors, are not removed with any certainty and completeness by straining, but are, under suitable conditions, oxidized or destroyed by the oxygen present in the water, with the aid of the organisms which establish themselves upon the sand grains, and which by their presence cause these actions to take place.

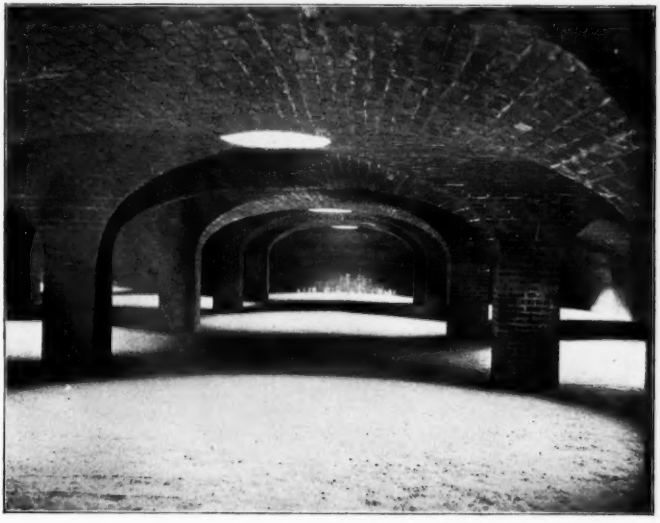
The removal of the bacteria, including the germs of disease, is effected, in part, as a simple straining operation, and, in part, in connection with the biological changes resulting from the presence of very active life upon the sand grains of the filter.

The question is sometimes raised as to the completeness of the purification which can be effected in this way, and whether or not a water once polluted will not always remain more or less injurious to health. It may assist us to arrive at a correct understanding of the power of the processes involved in sand filtration to consider what is accomplished in sewage purification. The comparison is justified, as the waters of many rivers, particularly in dry weather, are simply dilute sewage.

Sewage has been purified for many years and for many cities by filtering it through sand beds intermittently. The oxidation and bio-

logical changes which take place in these beds are similar to those which take place in water filters. They differ principally in their intensity, owing to the greater richness of the food-supply in sewage. The purification which takes place in a well-built and regulated sewage filter is extraordinary. Certain organisms attach themselves to the sand grains and remain fixed while the sewage flows by them, and they take from it, as it passes, the organic matters which form their food-supply and which constitute the most objectionable matter in the sewage. As a result of the assimilation of these matters by the vital processes of the organisms resident in the sand, the organic matters in the passing sewage are removed, and in large measure destroyed and converted into harmless mineral products, the most important of which are carbonic acid and nitric acid, the latter of which combines with the alkaline earths always present, forming nitrates.

It is a matter of common experience that filters of this kind, of sufficiently fine material and within proper limits, actually remove and destroy from ninety-five to ninety-nine per cent. of the organic matters of the sewage passing them, and at the same time remove the



INTERIOR VIEW OF COVERED FILTER.

When in use water covers the sand and rises nearly to the springing line of the vaulting. (Ashland, Wis.)

CLEANING A FILTER, EAST LONDON.

bacteria even more completely than the organic matters. Large numbers of bacteria find themselves incapable of existing in the presence of the changes taking place in the filter, and thus lose their lives. Others are removed by the straining, and eventually die. At the Lawrence experiment station of the Massachusetts State board of health filters are now in use which have been constantly receiving sewage for ten years, yielding effluents rarely containing more than two per cent. of the organic matters of the sewage, and sometimes not more than one in a million of the bacteria. So complete is this purification under favorable circumstance that, from sewage taken directly from one of the Lawrence sewers, effluents are produced as bright, colorless, and sparkling as any spring water, entirely free from objectionable taste or odor, and generally suitable for drinking purposes. I have drunk such effluents from undiluted sewage at the Lawrence experiment station hundreds of times, and also on numerous occasions effluents from the sewage of cities and towns both in America and in Europe. These effluents have also been drunk by large numbers of persons, and, although careful inquiry has been made, no reason has ever been found to think that the health of anyone has been injured by such use.

PAVED EMBANKMENT BETWEEN TWO FILTERS, EAST LONDON.

What has been thus accomplished with sewage can certainly be accomp-

lished with the much more dilute sewage which flows in many rivers.

It may be questioned, and with reason, if it will be possible at all times to operate water filters to secure effluents of the greatest purity. Accidents will happen sometimes, and one would hardly recommend the use of purified sewage for the public water-supply of a city.

RECONSTRUCTING THE UNDERDRAINAGE SYSTEM OF A FILTER AFTER 26 YEARS OF USE, BREMEN, GERMANY.

The answer to such a question is best furnished by reference to the records of the very numerous cities in Europe, and the smaller number of cities in this country, where filters for public water-supplies taken from sewage-polluted rivers have been in use for long periods. Very few cases are recorded where there is reason to suppose that disease was caused by the use of filtered water. The few cases which have occurred are particularly instructive as showing the precautions necessary to prevent the recurrence of the conditions. The most important cases of this kind have resulted from the passage of water around the filters, and not through the sand. Such cases are obviously due to defects in the method of connection or to gross carelessness, and not to any fault in the process of filtration. Other cases have resulted from the use of improper filtering material, or from insufficient depth of filter, and especially from too high rates of filtration. In a few cases reduced bacterial efficiency has resulted from passage of water from above the sand to the underdrains through cracks in the masonry walls, caused by settlement; such results can be prevented by keeping the underdraining material back a little from the bottom of the filter walls, so that, even if water gets down in this way, it will nevertheless have to pass through a certain distance of sand on the floor of the filter before it can reach the pure water channels. Decreased bacterial efficiency has also resulted sometimes from the effect of frost in severe climates with open filters, and in a few cases this disturbance has gone so far as to result in the discharge of water of a distinctly unhealthy character.

INLET FOR ADMISSION OF RAW WATER TO A FILTER, EAST LONDON.

Defects of this kind are of such a character that they can be provided against by careful design and construction, and in the newer filter plants, constructed since the theory of filtration has been better understood, the arrangements are such as to make inferior results from the causes mentioned almost impossible.

In a few cases, where it has been necessary to use waters polluted to an unusual extent, double filtration has been employed. That is to say, the effluents from filters are carried to a second set of filters, so that there are two lines of protection to the consumers, either of which should be sufficient. In this case the failure of any part of the plant to do its duty need not be followed by any appreciable reduction in the quality of the water supplied.

The question of the quality and safeness of a water-supply is largely a relative one. No supply can be said to be absolutely free from danger. Supplies from impounding reservoirs are subject to various sources of pollution, and often require to be filtered. While it must be admitted that there is some danger from the use of purified water from a polluted stream, there is good evidence that, with the best appliances and manipulation, this danger can be so far reduced as to be hardly appreciable. This is borne out and emphasized by the successful use, by a large number of cities, of purified waters from highly-polluted rivers. To mention only a few cases, London is supplied from the Thames and the Lea; Hamburg and Altona are supplied from the Elbe; Berlin was formerly supplied from the Spree within the city limits; Lawrence is supplied from the Merrimack river, nine miles below Lowell; and Hudson and Poughkeepsie from the Hudson below Albany and Troy. All these cities show death-rates which, so far as diseases conveyed by drinking water are concerned, compare favorably with those of other cities similarly located and having public water-supplies from unpolluted sources.

In fact, it has been stated, and apparently with reason, that, on

GENERAL VIEW OF FILTERS AT HAMBURG, GERMANY.

Water from the River Elbe (shown on the right), then used without filtration, caused the cholera in 1892. The filters now purify this water and protect the city from a recurrence of the attack.

the whole, the dangers attending the use of water from a highly-polluted river, after it has been filtered through a properly-designed filter plant with ordinarily good management, are less than those attending the use of unfiltered water from impounding reservoirs upon the sparsely-inhabited water-sheds used by many cities. That is to say, the unavoidable pollutions of such impounded supplies, among which should be remembered the droppings of birds, wild animals, dogs, etc., and the pollutions from camping parties, in addition to those from permanent population, are in the aggregate a greater source of danger than are such germs as are able to pass through a good filter plant.

It has been said of water that innocence is better than repentance; but honest and thoroughgoing repentance is not to be despised, and, where the only sufficient sources of water within reasonable distance of a large city are rivers which long ago lost their original purity, we are justified in the attempt to correct the evils. The successes already achieved give promise of a large and useful future to the art of water-purification.

MINING THE GOLD ORES OF THE WITWATERSRAND.

By H. H. Webb and Pope Yeatman.

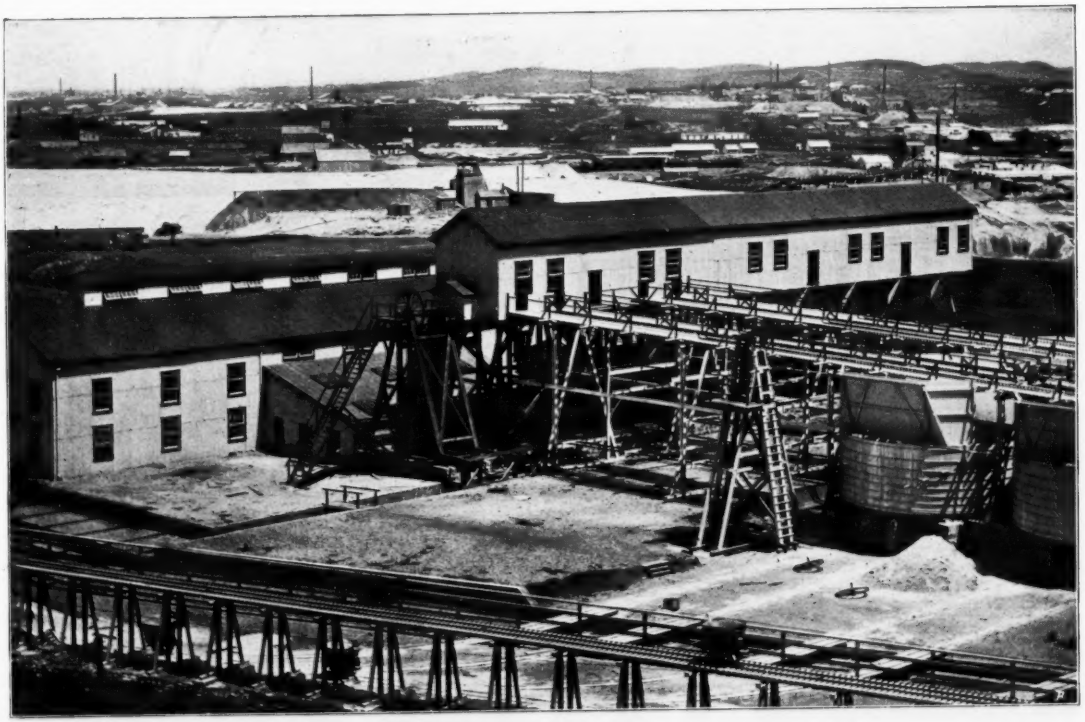
THE mechanical equipment of the Rand properties does not perhaps present marked contrast in types to the equipment of similar plants in other great mining districts. In more distinctively economic features, however, the conditions are more peculiar to the region, sharing in greater or less degree characteristics which mark all localities difficult of access.

Supplies.—If we include under this heading native food, timber, steel, oils, paraffin, candles, ropes, spares of all kinds, chemicals, sundry stores, etc., they will amount to 20 per cent. or more of the whole working costs for mining and milling. Fortunately for the Witwatersrand the percentage of timber used, except in construction, is small. All supplies and material for construction and equipment are so intimately connected with freight rates that the latter have an important bearing on mining costs. It is difficult or impossible to get at the exact ratio of these costs to total working expenses. There are five railroads connecting the Transvaal with different ports on the coast, but within its boundaries all trade is controlled by one company, the profits of which for 1896 have been estimated at almost as much as the dividends of the whole mining industry for that year. In operating expenses freights form probably 6 or 8 per cent. of the total; in construction costs they are a very heavy item. Evidence produced at the sitting of the commission has shown that the charges on timber imported in various forms have averaged from Delagoa bay to the Witwatersrand—a distance of 394 miles—about 300 per cent. of the original cost. On a consignment of pitch pine, the original cost of which was £1,722, the railage amounted to £7,234; on a consignment of Oregon pine, prime cost being £2,988, the railage from Delagoa was £14,500. Seventy-five items of machinery and plant shipped *via* East London—a distance of 666 miles—showed an average railway charge of nearly 37 per cent. of the home cost of the various material, the highest being 469.5 per cent., in the case of Portland cement, a large quantity of which is used in construction, and on which there is also a special Transvaal duty of 3s. per hundred pounds. On these seventy-five items the percentage on home cost of importing charges was 16½.

Explosives. — The government gives the following statistics of consumption of explosives for 1896 on the Witwatersrand alone: dynamite, 33,858 cases of 50 pounds each; blasting gelatin, 109,598 cases. The dynamite cost 91s. 10d. per case and the gelatin 107s. 4d. per case. The entire quantity is supposed to be manufactured in the Transvaal, a monopoly of this trade being in the hands of one company. Hitherto all the dynamite and gelatin have been imported as such, and made up into cartridges. Of late efforts have been made at home manufacture, from imported ingredients. The quality is, as a rule, inferior, and the action irregular; foul and copious fumes are emitted, and there are frequent failures to explode, which are a source of danger to life because of the liability to unexpected explosions later. The cost of explosives per ton varies, probably averaging at least 9 per cent. of the total working costs and amounting to from 2s. to 3s. per ton of ore mined. In shaft-sinking an average of nine shafts, 25×6 feet in the clear, showed the cost of explosives as 5.12 per cent. of total working costs, and a cost per ton of rock broken of 1s. $8\frac{3}{10}$d. for explosives.

In stoping we know of two large mines adjoining each other in one of which the cost for explosives per ton of ore milled is 1s. 4d., and in the other of which it is from 3s. 3d. to 3s. 6d., the difference in the latter case being due probably to the use of air-drills. In driving and development generally the cost in opening up a well-managed deep level, preparatory to milling, has averaged from 4s. 6d. to 6s. per ton of rock taken out.

Water-supply.—The question of an ample water-supply is being given more and more attention each year, and even some of the outcrop mines, which, being the first to be worked, had the call on the available water, have been obliged to shut down for short periods during the long droughts, on account of the shortage of water-supply. As the reefs outcrop along the top of the watershed between the streams flowing into the Atlantic on the west and the Indian ocean on the east, there is no large catchment area in the vicinity of the mines, and they are limited to the conserving of water from very small areas during the short rainy season. The amount of water pumped from the mines is small, much too little for the mining requirements, and in the deep levels the amount is still less, in proportion, than in the outcrops. Mr. W. H. Hall estimates that the outcrop ground yields about 50,000 gallons per shaft, the first row of deep levels about 45,000 gallons per shaft, and the second row of deep levels not more than 2,500 to 5,000 gallons per day. Then, too, the mine water is usually very acid, on account of the oxidizing of the pyrites in the ore, so that the boilers and pipes suffer greatly.

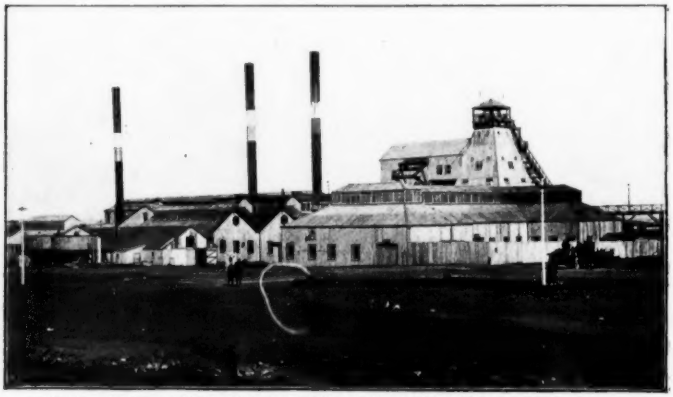


AN EXAMPLE OF MINE BUILDINGS.—THE SIMMER & JACK CYANIDE WORKS.

Every endeavour is made to recover all possible water after using; so, in addition to the main dams for impounding surface water, there are tailings and slimes reservoirs, where the water from the tailings and slimes is caught, to be pumped back to the mill and used over again.

Much capital has been expended in dams. Along every small spruit and dry creek, dams of greater or less extent have been built to catch storm-water. The largest of these are those built by the Rand Mines, the one on the Natal spruit holding not less than 700,000,000 gallons, and being built of masonry.

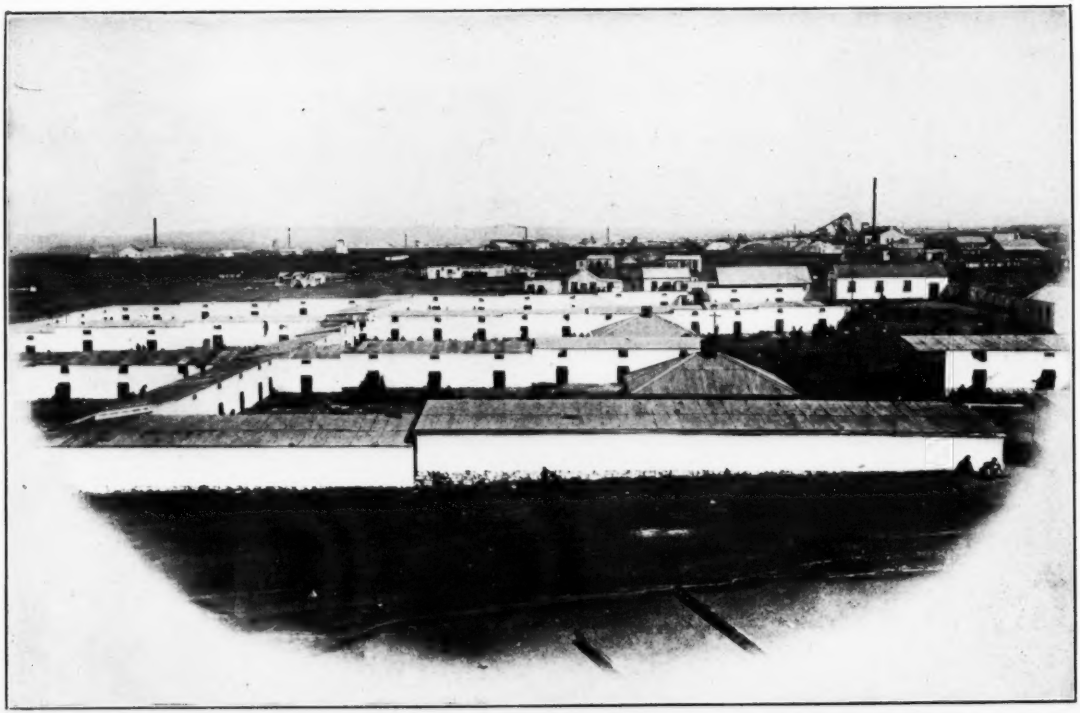
From these dams the water is pumped to large distributing reservoirs, from which supplies are drawn. Though simple in construction, they represent the outlay of considerable capital. They are



MILL AND SURFACE WORKS, KNIGHTS (WITWATERSRAND) G. M. CO., LTD.

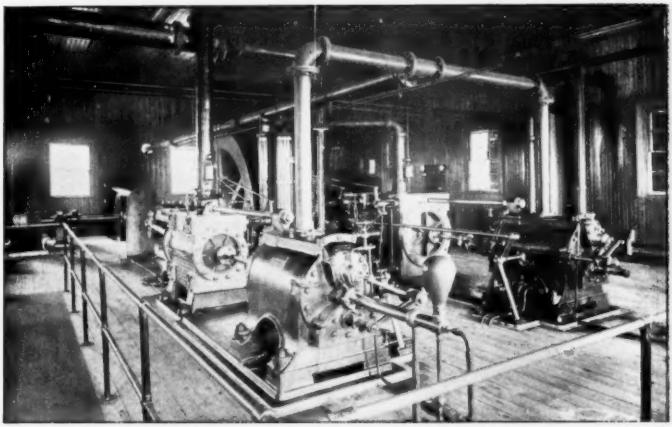
partly excavated, and the sides are partly built up of excavated material, and puddled and pitched with stone on the inside.

Buildings.—The mine buildings are usually substantial and well designed. They are commonly built of corrugated iron, that material being cheaper than wood or stone, and sufficiently durable. It is customary for the mines to have, in addition to blacksmith and carpenter shops, their own machine shops, and some of these plants are most complete. Each mine has its office and store, and, for its employees, comfortable rooms for single men and cottages for married men. In addition, there are usually very good houses for the officials. On the larger mines recreation rooms are furnished for the employees, and the men are well looked after in case of sickness. There is always a doctor, and on some mines hospitals are erected. Other buildings on the property are for the stamp mill, cyanide plant, etc.



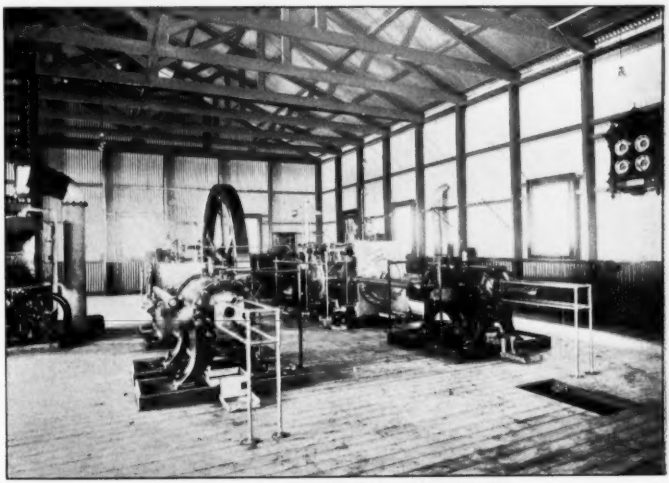
NATIVE COMPOUND, HOUSING 3000 NATIVE MINERS. NEW PRIMROSE GOLD-MINING CO., JOHANNESBURG.

A REPRESENTATIVE SHIFT. ABOUT 5000 NATIVES ARE EMPLOYED AT THESE MINES.



INGERSOLL-SERGEANT COMPRESSOR PLANT, ORIGINALLY EXHIBITED AT THE WORLD'S FAIR, CHICAGO. NOW AT THE CROWN REEF.

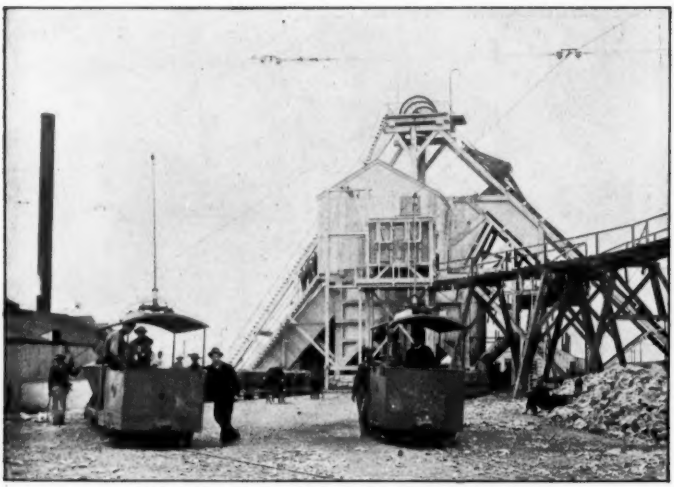
White Labour.—Men of many nationalities are found on the Rand, but 80 per cent. of the employees are British subjects. The class of labour is gradually improving, but all white labour may be said to be more or less demoralised, on account of the large amount of manual work falling to the natives. The white man feels it below



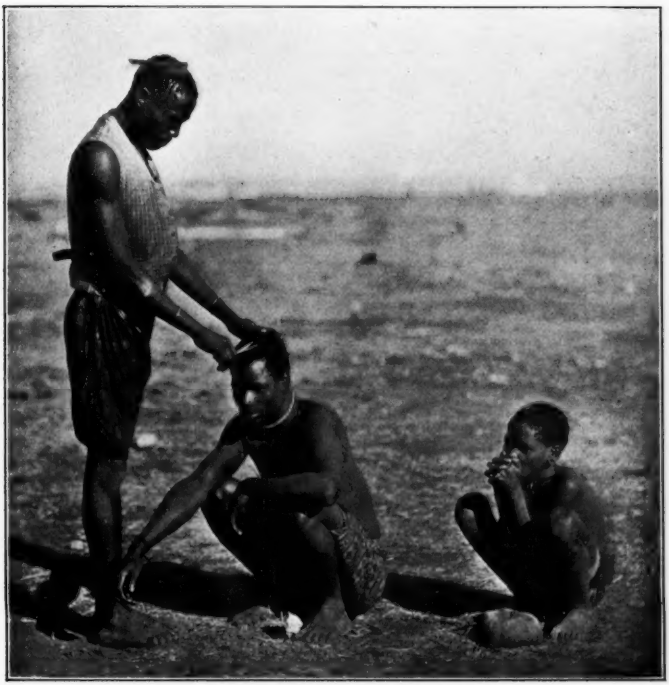
A RAND DRILL COMPANY COMPRESSOR PLANT.

PAYDAY AT THE SIMMER & JACK MINES, MIDWINTER.

his dignity to perform any manual labour while a kaffir is about. It is told of one of the most prominent managers on the Rand that, at one time, having a piece of important work to be done and not wish-



HEADGEAR AND ELECTRIC TRAMS, CROWN REEF MINE.



A NATIVE BARBER.

ing to draw off native labour, he detailed some of his best white men to do the job, allowing them one native as a roustabout. Later in the day, on inspecting the work, he found the white men engaged in "bossing up" the nigger, who was the only one of the party who was working.

Nearly every white man has charge of two or more kaffirs; in other words, nearly every man is a boss; but, as a good boss is a rarity, work is not by any means directed to the best advantage.

According to the State mining engineer's report, the number of whites employed on the fields for 1896 was 9,619, including men employed at the mills, cyanide works, and construction and surface work, as well as in the mines; and the total wages paid for white labour was £252,993.

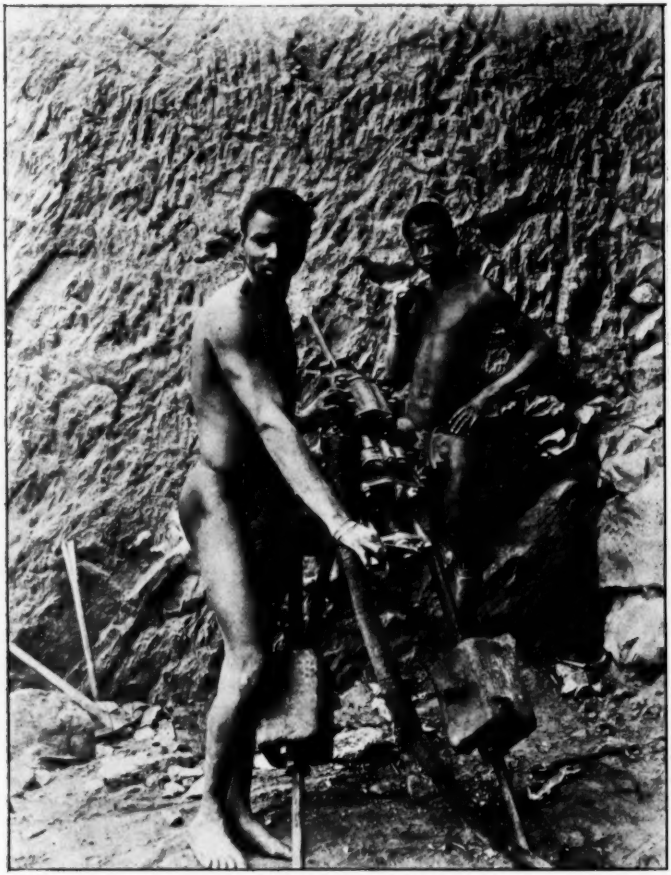
The following schedule shown in the same report gives monthly wages paid for the different classes of work:

Mine overseers	£44.	9.	0
Shift bosses	28.	0.	0
Miners and trimmers	22.	6.	0
Machine drillmen	27.	9.	0
Engine drivers	25.	6.	0
Pump men	25.	10.	0
Stokers	19.	2.	0
Carpenters	25.	18.	0
Blacksmiths	31.	18.	0
Fitters	26.	12.	0
Painters	21.	17.	0
Masons	26.	10.	0
Labourers	18.	11.	0

The fields are wonderfully free from strikes. This is due to several causes, the principal being that the government is not in sympathy with the foreign workingman, who has no voice in elections, so that the officials are in no way dependent on the men for their votes. Several attempts have been made in a small way to carry on strikes; but, when any signs of violence or intimidation appear, the police interfere, and the courts sustain their action. That, except in the case of a high class of skilled labour, much of the work of the whites can be done by the natives, between whom and the whites there is

A KAFIR FAMILY AT HOME.

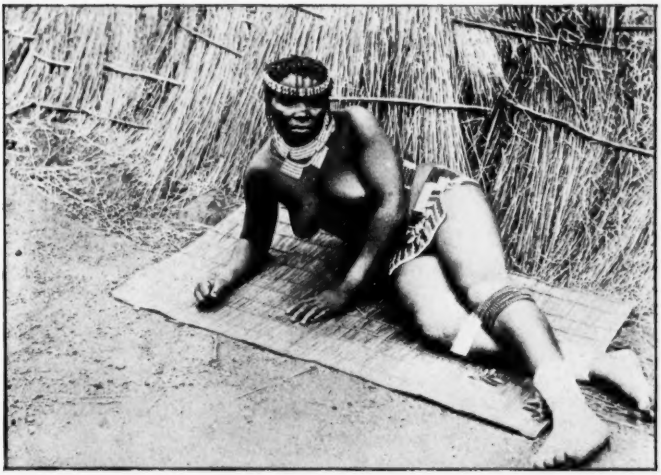
A PIONEER DIAMOND DRILL IN THE SOUTH AFRICAN GOLD FIELDS.



KAFIR MINERS OPERATING A ROCK DRILL.

little sympathy, is an important factor in deterring European labour from striking. The fact that good wages are paid is, as is well-known, not proved by experience to be any sufficient reason for the avoidance of labour troubles.

As shown in the evidence before the industrial commission, the average rate per man paid in a well-managed developing mine is 19s. 6.6d. per shift; in a working mine, about 18s. 6d. In a de-

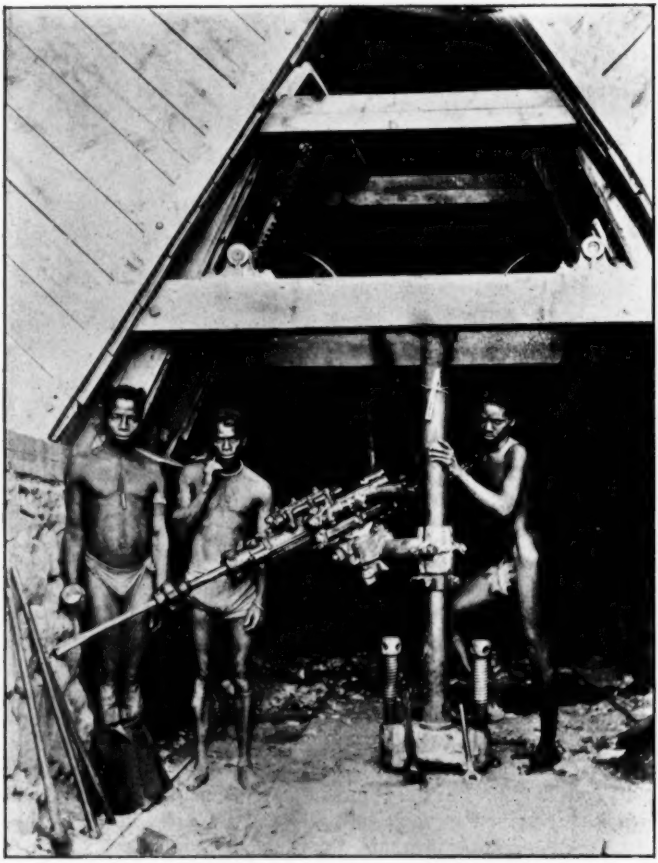


THE WIFE OF A KAFIR MINER, IN FRONT OF HER KRAAL.

veloping mine, and where construction work is being carried on, more skilled labour is required than in a working mine.

Native Labour.—One of the most serious problems on the Rand is the supply of sufficient native labour. The natives are secured from as far south as the Cape and from north of the Zambesi. The proportion from the Transvaal is extremely small. Competition among the mines has been very great, and the result has been a great increase in wages. However, a year ago the managers came together and arranged a reduction, and later in the year a further reduction was made, so that at present the rates paid are not excessive. At certain seasons of the year the supply falls very short, notably in the spring, when the natives are called home for ploughing, and later for harvesting. Then again, in case any tribe is at war, the "boys" belonging to such tribes are called home by their chiefs. For instance, when the Shangaans, who live in Portuguese East Africa, were at war with the Portuguese, the industry was crippled by their being called home to fight.

The natives are docile and intelligent, and it is remarkable how little time it takes to teach them to work, especially to drill. They are used for all kinds of unskilled and manual labour. Of course, the number of untrained "boys" is very large, for the reason that the mines are increasing their working forces, and many of the old



A DRILL IN CHARGE OF NATIVE WORKMEN.

"boys," when they have made enough money, go home, buy wives, and do not return.

The cost of collecting the "boys" and sending them to the mines is considerable. Some companies have their own collectors; others obtain their natives from independent labour agents; while most rely on the Rand native labour department under the control of the chamber of mines. This association has its agents scattered throughout South Africa, and on the main roads leading to Johannesburg

THE WIFE OF A NATIVE MINER.

their compounds are about a day's travel apart. At these the gangs of imported natives can obtain rest and food. "Boys" coming from Natal, the Colony, Orange Free State, and the Delagoa Bay district are brought in by rail. Were desertion among the boys an uncommon occurrence, and did they remain at any one mine for a considerable period, the cost of collecting would not be burdensome. Were the pass law well administered, desertion would be greatly decreased.

The greatest curse of all, in regard to the native labour question, is that of drink. Early in the week as much as 20 per cent. of the mine natives are unable to work, on account of drunkenness. While there is a law prohibiting the sale of drink to natives, it is not carried out.

The "boys" are fed and housed by the companies, and medical attendance is given.

All natives are under the control of a compound manager, who, with a staff of native police, sees that proper order is kept, and that the boys turn out to work. He attends to the food allowance, looks after the sick, and, in fact, is local governor. The natives look on the compound manager as their chief, and his word is law.

A "boy's" food allowance is limited to 2 pounds of mealie meal per day, and 2 pounds of meat per week. The cost for native food averages about 4 per cent. of the total working cost.

KAFIR GIRLS.

RETURNING HOME FROM THE JOHANNESBURG MINES.

Some of these boys come on foot more than 1000 miles, returning the same way loaded with 300 lbs. of baggage. The native miner's code of life is: "Six pieces of white man's gold will buy one cow; four cows will buy a nice little wife; half a dozen wives will tend my mealie patch while I smoke and look on."

The following is the schedule adopted by the chamber of mines for native wages for the mines:

MINE.

	s.	*d.*
Machine helpers	1	8
Hammer boys	1	6
Shovel boys	1	3
Tram boys (10 ft. trucks)	1	2
Tram boys (16 ft. trucks)	1	6
Dry shaft and winze boys	1	8
Wet shaft boys	2	0
Wet shaft boys when developing only	2	6
Boys cutting hitches for timber	1	6
Timber boys	1	2
Stope ganger's assistants	2	0
Station boys (white man employed)	1	2
Station boys (no white man employed)	2	6
Air hoist drivers	2	0
Pumpman's assistants	1	8
Platelayer's assistants	1	6
Pipeman's assistants	1	6

SURFACE.

	s.	*d.*
Stokers (12 hrs.)	2	6
Stokers (8 hrs.)	1	8
Engine cleaners	1	6
Sorting boys	2	0
Headgear boys (white man employed)	1	4
Headgear boys (no white man employed)	2	6

GENERAL.

	s.	*d.*
Fitter's boys	1	6
Blacksmith's boys (strikers)	1	6
Blacksmith's boys (helpers)	1	4
Carpenters' boys	1	2
Mason's boys	1	4
Police	2	6
Compound cooks	2	0
Drill packers	1	0
Drill sorters	1	6
Surface labourers	1	2
Office and store boys	2	6
Assay office boys	2	6
Coal boys (off-loading)	1	6

Working Costs.—The working costs of the various mines have been collected, classified and tabulated, and from a table prepared by the State mining engineer the percentage of the different items which constitute working costs of all the mines on the Rand for 1895 are given as:

		Per cent. of Total Cost.
White labour	£2,400,000	34.3
Kaffir labour	2,000,000	28.6
Coal	700,000	10.0
Explosives,—*i. e.*, dynamite and gelatin	600,000	8.6
Mining timber and sawn lumber	300,000	4.3
Cyanide	240,000	3.4
Meat, mealie, and mealie meal (being for most part food for kaffirs)	250,000	3.6
Iron	85,000	1.2
Candles and paraffin	95,000	1.4
Tools	70,000	1.0
Steel	65,000	0.9
Mercury, zinc, and other chemicals	45,000	0.6
Caps, safety, ropes, cement, etc.	150,000	2.1
	£7,000,000	100.0

By comparing the costs with the output, the cost per ton both for mining, milling and development may be deduced, and a total average working cost per ton found, which will serve to show the progress which has been made in successive years in the mining operations of the region.

Such an analysis has been made by Mr. Jennings, and tabulated in a detailed manner, giving not only the percentage of total cost for all the various items of expenditure, but also the proportion per ton milled, enabling a very clear idea to be obtained of the relative importance of the different portions of the expense account.

In Mr. Jennings's evidence before the industrial commission the following analysis of the working expenditure of six prominent companies is given for 1896:

	Cost per ton. s.	d.	Per cent. of total cost.
Native labour	6–	9.62	23.73
Native food	1–	2.24	4.14
White labour, salaries, etc.	8–	7.78	30.18
Coal	2–	4.35	8.24
Dynamite	2–	10.13	9.92
Fuse and detonators		1.97	0.57
Cyanide		8.12	2.36
Zinc		0.62	0.18
Mining timber		2.98	0.87
Timber deals, etc		4.05	1.18
Steel		4.21	1.22
Oils, grease, and paraffin		3.73	1.09
Candles		4.15	1.21
Ropes, steel, and manilla		0.93	0.27
Electric spares		1.47	0.43
Mill, spares, shoes, dies, cams, cam shafts, stems, mortar boxes, screening, etc.		4.59	1.34
Trucks, wheels, and rails		2.24	0.65
Sundry stores, bar iron, bolts and nuts, buildings, machinery, assay, chemicals, pipes and pipe-fittings, etc.	2–	0.73	7.19
General charges: insurance, licenses, rent, printing, and advertising sundries	1–	5.99	5.23
	28–	7.90	100.00

From the same evidence the average of twenty-nine companies is given at 13s. 4d. for mining per ton milled, and mine development and redemption at 4s. 3.5d.; the total average working cost per ton is put at 27s. 4d.

More recent reports show a general lowering tendency for 1897:

Simmer & Jack.....20s. 6.67 d. per ton.
The Geldenhuis Deep.....21s. 2.594d. per ton.
The Meyer & Charlton.....18s. 11.654d. per ton.

Reductions.—The question of possible reductions is one that admits of so many ramifications that exact estimates are out of the question. The very cost of living, which is directly proportional to the cost of food stuffs, and which has a direct influence on the wages paid, has an important bearing on the mining industry and the government itself.

In the Transvaal agriculture seems almost a dream, and a farmer has been known to answer, when questioned why he did not increase his little acreage: "What is the use? an increase in production will tend only to bring down the market price." This in a country where hay sells by the pound and averages £20 per ton, and where corn is imported from America, butter from Sweden, and canned goods of all descriptions from the outside world. With a fine market ready to pay extravagant prices, the necessities of life are, in a very great measure, imported. As a consequence, as shown by Mr. Goldman at

the sitting of the commission, out of a total of 3,620 white miners employed by 53 companies, 12.9 per cent. are married men living on the properties with their families, 33 per cent. married men on properties without their families, and 54 per cent. single men.

The single industry of the country is mining; the government is supported by mining, and the country, as a whole, lives on the industry, with little effort to supply from within the demands created by it. The possibilities are great. Immediate reductions in mining costs might be effected by cheapening coal and dynamite and lowering freight rates and wages. The price of coal can be reduced by cheaper production at the collieries, by shipping in bulk instead of sacks, and by sidings at both the collieries and the gold mines. That of dynamite would fall, if the market were thrown open to the world and freight rates were reduced. Freight rates will decline when there is a spirit on the part of the railway to meet the requirements of the mines. The possibility of the expropriation of the railway by the government has probably had the effect of creating the desire to make all possible profits before such action should be taken.

It does not seem too much to expect that within the next four or five years the average cost of working Rand mines will fall to 18s. per ton. In the case of certain favoured mines a cost considerably less may be effected; at certain mines this figure has already been reached.

In estimating the cost of bringing a property on the Rand to the milling stage at the present day, the outcrop companies can hardly be taken as a criterion, having established plants varying in age and design. For the deeps, while the surface equipment will remain much the same as regards mill, cyanide, and slimes plants, the cost will vary with the depths to reefs,—that is, cost of sinking, shaft equipment, etc.,—and underground installation for excessive depths on the incline. The sum for fully equipping a deep level and bringing it up to the milling point may be said to vary upward from £500,000, depending on the number of shafts, depth to be sunk, and the size of the milling plant, the tendency being to lay down mills of more than 100-stamp capacity.

APPLICATIONS OF ELECTRICITY ON A MODERN WARSHIP.

By George H. Shepard.

THE auxiliary machinery of naval vessels is operated, in by far the majority of cases, by the direct application of steam; and, while various auxiliaries are driven by other means in certain ships, there is no purpose for which the auxiliary engine is not now much more commonly driven directly by steam than by any other means. This, too, in spite of the fact that there are many reasons why such application of steam is very objectionable.

The presence of steam and exhaust pipes anywhere outside of the main engine and boiler compartments is undesirable, especially in the crews' living quarters, where the heat that they produce in confined spaces densely inhabited is particularly bad. In addition, the presence of such steam machinery as the ice-machine and the ship's ventilating blowers in the crews' space, where it is generally necessary to place them, adds to the work of keeping the ship clean, both the blowers and the ice-machine requiring the presence of an attendant, whose time is mostly employed in cleaning up the oil and water about them. These, however, are minor disadvantages. A greater one is the obvious danger from steam-pipes above the protective deck, in action. This is met by placing below the protective deck all auxiliaries whose use would certainly be necessary in battle, and by shutting off steam from all the rest below the protective deck when the ship is cleared for action; but the capstan and the winches must be on deck, and their use may become imperatively necessary in action. In one ship, to the writer's knowledge, the ammunition-passing rooms are so warm that, to keep the men stationed there from giving out, the ventilating blowers, though above the protective deck, instead of being shut down at "General Quarters," have to be run up to twice their usual speed. The cutting of the steam pipe, above the protective deck, to any of these machines would render at least one compartment entirely untenable until steam could be shut off from below, to say nothing of the probable loss of life and disastrous moral effect. By far the most serious objection to these auxiliaries, however, is their lack of economy. Everybody knows they are wasteful, but just how wasteful it is difficult to say because of the rarity of tests under service conditions. The only data that we possess concerning naval auxiliaries under such conditions are the results obtained by Passed

Assistant Engineer W. W. White, United States navy, in a series of very careful experiments on the auxiliaries of the Minneapolis, made a little more than a year ago. In these experiments the condensed exhaust was measured and indicator cards were taken from thirteen different auxiliaries, beside the dynamo engines, including main and auxiliary air and circulating pumps, pumps for feed, fire, bilge, flushing, and water-service, one forced-draft blower, and the ice-machine. The mean result from these thirteen was 99.522 pounds of feed-water per i. h. p. per hour. The greatest economy was shown by the middle circulating pump engine, a simple, vertical, two-cylinder, inverted, direct-acting engine, with slide valves, actuating two centrifugal pumps. At the time of test the pump was working under its full load. The consumption was 55.06 pounds of feed-water per i. h. p. per hour. The least economy was shown by a horizontal duplex pump, 12 inches by 8½ by 10. At the time of test it was making an average of 12.7 double strokes per minute on a very light load. Its consumption was 318.68 pounds of feed-water per i. h. p. per hour.

In discussing Mr. White's paper when it was presented before the American Society of Naval Engineers, Mr. Charles Ward said:

"The resulting data are certainly startling. We have, of course, always known that the auxiliaries were fearfully extravagant in the use of steam, but who supposed that there were engines to-day using from 100 to 300 pounds of steam per i. h. p.? In the paper before us, giving the summary of tests to determine the consumption of steam of the main and auxiliary engines, we find there are thirty-four auxiliaries having in all fifty-two steam cylinders. Thirty-one of these engines were indicated, giving an aggregate of 471 h. p. developed, using collectively 56,049 pounds of water per hour, or an average of 119 pounds per i. h. p. Were these auxiliaries as economical as the main engines, 9,891 pounds of steam would have developed the same power. 46,158 pounds of steam or water being used *more than is necessary* if the best conditions of economy prevailed! In other words the data show that at 8 pounds evaporated per pound of coal, 5,769 pounds of coal can be saved per hour.

It must, of course, be borne in mind that it is impracticable to realize this gain because of the complications which would follow the introduction on board ship of high-expansion engines for these numerous purposes, but one is forced to put the question: 'What are you going to do about it?' Shall these numerous engines for as many purposes be brought together in fewer engines of higher character and have a few central power plants capable of meeting similar wants with greater economy; or shall we design more economic engines for each individual condition, even at the cost of slightly increased number of

parts; or shall we have one more economical central steam plant developing power to be distributed by electricity to the varied requirements in different parts of the vessel?"

Wastefulness is inseparable from any system requiring the development of power in numerous independent engines of small power situated at a distance from the boilers. Under such circumstances the losses by radiation and condensation must necessarily be greatly increased. Then, too, the use of numerous small engines causes a great increase of the friction load. Worst of all, each of such small engines must be large enough to do its maximum work; hence, under service conditions, it must often work at low powers with great waste of steam.

These troubles can be avoided by the use of one power plant for all the auxiliaries. Such a plant for a large man-of-war could be divided into a sufficient number of units, so that the generators in use could always be working at nearly their full load; and at the same time the units would be so powerful that compound engines could be used with consequent economy. In addition there would be the gain from the substitution of a few large engines for many small ones. The plant, of course, would be placed near the main boilers, avoiding much steam-pipe drop and condensation, would be below the water-line and well protected, and would keep its heat, dirt, and noise where they belong—in the machinery space.

Now, the dynamos for electric lighting must, of course, continue to be run by steam. In order, therefore, to run the central power plant to the best advantage by keeping its load as nearly uniform as possible, the distribution to the other auxiliaries should also be by electricity. By this means, when the night's lighting load goes off, the day's motor load could be put upon the same generators, instead of running two sets of generators, each at light load and heavy load alternately,—a necessity under any other system of distribution. There would, of course, be variations in the load; but electric light and power stations equipped with several units, operated by condensing engines, can run under wide variations of the total load, without greatly changing their steam consumption per i. h. p. Electricity is very adaptable to the conditions existing on board ship. The wires can be carried through water-tight bulkheads with less damage to the latter than that caused by the pipes necessary for any other system of power distribution. For the short distances on board ship the transmission losses are negligible. In starting machinery electricity can be applied with a quickness, certainty, and safety attainable with no other power, except possibly compressed air. Distant motors can be controlled from the central station. Moreover, the electric wires are,

of all transmission mains, the least liable to injury in action; and, if cut, the worst result is the stopping of the motor, or the extinguishing of the lights.

Yet at present electricity is hardly used on naval vessels, except for illumination, searchlights, interior communication, and some signals. Many vessels have special small ventilating blowers operated by electricity, usually in out-of-the-way-corners where the need of extra ventilation was discovered after the ship was placed in commission. Besides this, some ships have electric turret-turning machinery, electric control of steering engine, and so on. This is about the limit. It must be admitted that, from experience with such plants, most naval officers regard electric machinery on ship-board with distrust. If such distrust were justified, it alone would be a sufficient reason for condemning electric installations, for naval machinery must, of all things, be reliable. No advantages can justify the use, in an important auxiliary, of a motive power that is likely to fail in action or to require frequent repairs in peace cruising; but the dislike for electric machinery apparently arises from the fact that the electric call bells and telephones on board ship seldom work, and that faults in the electric mains are hard to locate. The electric-lighting plant generally works as well as any other apparatus on boad. Repairs to the dynamos are not uncommon, but they are usually required by the engines rather than by the dynamo proper, on which the repair work is generally limited to filing the brushes and smoothing and cleaning the commutators. Sometimes a small motor will call for almost constant overhauling and repairs, but there is often a direct steam-driven auxiliary to match it in this respect. It cannot be said, therefore, that naval electric machinery deserves a bad reputation. In fact, the policy of the navy department is, with due prudence and conservatism, to reach out after further applications of electricity, as may be illustrated by the following extract from the annual report of the chief of the United States bureau of construction and repair for the fiscal year ending June 30, 1897. He says: "A question which has received a great deal of consideration during the past year, and which has been the subject of much discussion, is that of the most desirable and efficient power for turning turrets. With all nations, and particularly with this country, the question of turret-turning gear is largely in an experimental stage, and opinions differ as to which is the most desirable. The original designs of turrets naturally provided for steam turning gear, receiving its motive power direct from the main boilers. In more recent years hydraulic, pneumatic, and electrical motors have been put forward, and each system has been given a trial on one or more ships. Electrical turning gear has been adopted by the

English, French, Russian, and German navies for small turrets, and by the French and Russians for the larger turrets of some of their recent vessels, each, however, still also using hydraulic gear for heavy turrets. The only departure by the English, apparently, is an experiment for assisting the hand turning gear by means of a 5-h. p. motor in the case of the heavy turrets of the Prince George. In January, 1896, the department decided, in order to obtain the best possible information as to the comparative merits of steam and electrical turning gears, to install both on the cruiser Brooklyn, two 8-inch turrets being operated by steam and two by electricity. Thus far the results seem to favor the electrical mechanism, the principal advantage being in the certainty and accuracy with which it may be operated. The department has since decided to equip battleships 5 and 6, Kearsarge and Kentucky, with electrical motors throughout the turrets, for controlling all operations, and, as this includes 13-inch turrets super-imposed with 8-inch turrets, the test is by far the most severe that has yet been applied by any government, and, if successful, will no doubt establish the superiority of the electrical mechanism. Nevertheless, considerable experiment is involved in this case, and the bureau has thus far urged that it be confined to these vessels, until some definite data are obtained, although it believes that the electrical system is probably capable of greater progress and improvement than any other now in use."

It must be admitted that the conditions on board ship are very trying to electrical appliances. Salt water, salt air, steam, heat, coal dust, and oil combine to produce rapid deterioration. Besides, the weight must be kept at a minimum, and there are no manufacture or repair shops at hand to remedy defects. To meet the conditions, a special marine installation has been developed. The marine generator is a special type, multipolar to reduce the weight and speed, compound wound for self-regulation, and fitted with a field rheostat to provide against changes of resistance of the field coils with changes of temperature. The insulation must be especially good throughout, because it is the weakest point under the conditions noted above, because the electric wires, once laid, are mostly very inaccessible, and because faults in them are hard to locate. The insulation resistance of the armature and field coils, above all, has to be carefully inspected and tested, and should not be less than one megohm. The importance of the dynamo-room requires that it be placed below the protective deck, and consequently it is one of the hottest places aboard ship. The naval specifications, therefore, allow a maximum temperature rise above the surrounding air (measured after a full load run of at least four hours) of only 50° F. in any part of the dynamo. Under the un-

favorable conditions no more can be allowed without risking an internal heat, that, in time, would ruin the insulation and necessitate extensive repairs.

Special appliances of marine type have also developed,—switches, junction-boxes, stuffing-tubes, etc. The switch-board is of prime importance. No wood or other combustible material can be allowed in its construction, and the body of the board must be made of slate or marble.

The wiring is the most difficult and expensive part of the installation, and requires the best materials and the most skilled workmanship. Experience has shown that a two-conductor, insulated, metallic return system is necessary. Attempts have been made to use cheaper and more convenient systems, but without such success as to warrant their adoption on vessels of war.

As might be expected under such circumstances, the first cost of a marine electric plant is very high,—about 100 per cent. greater than that of a similar shore-plant.

In spite of the obstacles in the way of so extensive an electric installation aboard ship as would be necessary to drive all the auxiliaries, the economy attainable is sufficient to make it well worth consideration. A good compound engine, working at nearly its full load, will indicate 1 h. p. for every 20 pounds of steam used per hour. In fact, many such engines have developed 1 h. p. on 18 pounds of steam per hour. For the combined efficiency of an engine and dynamo, direct connected as aboard ship, 82 per cent. is a fair figure; for a motor efficiency, 88 per cent. Taking these figures, we find that, with such a plant as is mentioned above, 1 h. p. could be developed by the motors for every 27.75 pounds of steam consumed by the engine per hour. In Mr. White's experiments the lowest steam-consumption per i. h. p. per hour found in any auxiliary was only a trifle less than twice this amount; and the mean consumption found, omitting the dynamos, was more than 3.5 times as much. With the present small electric installations, it has not been worth the increased weight and first cost to run the dynamos with other than simple engines; therefore, in combining the lighting dynamos with others in one central plant, there would be the gain of compound engines over simple ones of the same power. Theoretically, this would be only about two pounds of steam per i. h. p. per hour; but, in Mr. White's experiments, even after fitting the dynamo engine pistons with packing rings to increase their economy, they still showed a mean consumption of 71.65 pounds of steam per i. h. p. per hour.

As vessels of war spend by far the larger portion of their time in port, any estimates of expenditures for auxiliaries must be based on

port, rather than sea, conditions. A careful estimate, based on Mr. White's experiments, shows a consumption in port of about 6,000 pounds of steam per hour by the Minneapolis's auxiliaries, excluding the steam boats, but including the condensation in the auxiliary steam line. If this ship had a central lighting and power station, furnishing electric power to all the auxiliaries, and operating with the efficiencies estimated above, the corresponding consumption of steam would be reduced to about 1,600 pounds per hour. The Minneapolis burns in port about 33,000 pounds of coal per day for all auxiliaries except steam boats. Assuming the coal- and steam consumption to diminish in the same proportion, with a central lighting and power station and electric transmission, about 8,700 pounds of coal per day would run all the necessary auxiliaries in port, except steam boats, effecting a saving of about 24,000 pounds of coal per day. It is hard to estimate the average price paid for coal by naval vessels, on account of the widely-varying prices in different parts of the world ; but seven dollars a ton would be below rather than above the truth. At this rate, the saving to the Minneapolis would be about seventy-five dollars a day in port, and somewhat more at sea.

However, in a question of economy, first cost must also be considered. In changing from direct steam-driven to electrical auxiliaries, we should not only be changing to a system that is very expensive, but we should be putting in three machines to do the work formerly performed by one, so that the first cost of the electric system would be almost three times that of the steam system. Besides, the bill for repairs would certainly be greatly increased by the greater number of machines in operation, so that the electrical system could not be expected to pay for its increased first cost in less than five or six years of constant use. Still, it might be worth installing, regardless of economy in the long run, on account of its other advantages, especially the increased steaming radius at low speeds that would be obtained by saving several tons of coal every day on the auxiliaries.

For a first-rate protected cruiser about 1,600 i. h. p. would be allowed for the auxiliaries. For a battleship, with heavy turret and gun machinery and powerful ammunition hoists, this allowance would be increased to about 2,400 i. h. p.; but, as these allowances are ample for all the auxiliaries, we can safely assume that one half the amounts will supply all the auxiliaries ever in use at one time.

Basing our calculations on 1,200 i. h. p. for the battleship, and allowing the same motor efficiency as above, we find that we shall need dynamos developing 1,014 kilowatts. The naval searchlights now in use require 50 volts. To enable incandescent lights to be supplied from the same dynamos without too much dead resistance

in the searchlight circuit, the electric plants of our naval vessels use a potential of 80 volts, and other navies use an even smaller potential. With 80 volts, then, to develop the necessary power a current of 12,680 amperes is required. At the same time it is impracticable to install on board ship dynamos of more than 1,000 amperes, so that thirteen dynamos would be required to give the necessary power at 80 volts. Any one who knows how crowded the present war-vessels are will at once admit the impossibility of finding room on a battleship for thirteen such dynamos, in addition to the space already occupied by machinery.

On account of the excellent conductor furnished by the hull of a steel ship, and the great number of people who live aboard a man-of-war, grounds on the latter become uncommonly dangerous to life. For this reason no advantages could justify the use of more than 220 volts in a naval plant. Even this might prove fatal to some people; but, assuming that 220 volts may be used safely, and that the difficulties in the way of supplying the lights from the same dynamos can be overcome, we find that five dynamos will suffice, and that one more will bring the reserve up to 30 per cent., which is in accord with present naval practice. The total number of dynamos required would thus be reduced to six, for which room might be found, though with difficulty.

Each one of the six dynamos must be driven by an engine of 360 h. p. Moderate-speed dynamos of the voltage and power thus obtained weigh about 97 pounds per kilowatt, and the compound engines weigh 184 pounds per i. h. p., making the total weight for the six engines and dynamos 524,000 pounds. The navy specifications limit the gross weight of generating sets to one-third of a pound per watt of rated capacity. Such sets are operated by simple engines; but, even admitting that compound engines can be brought down to the same limit, we still have a gross weight of 440,000 pounds. The lowest weight which can be assumed for the motors is 135 pounds per kilowatt. To supply the 2,400 h. p. required for all the auxiliaries, a total weight of 241,650 pounds would be needed, making the weight of engines, dynamos, and motors 681,650 pounds. The present weight of auxiliaries of a first-class battleship can be safely estimated at somewhat more than 100 tons, making the weight of the necessary electrical installation almost exactly three times that of the present steam system. The electric wires would, of course, be lighter than the present steam and exhaust piping, but the saving thus effected would be of no use in comparison, being only about one-third of the weight of the present steam circuit.

The shore engineer may not appreciate how closely the marine en-

gineer and the naval architect must watch their weights. Ship design, especially war-ship design, is a constant struggle to save weight, in order that the war vessel, on a given displacement, may have the speed, protection, and offensive power to enable her to meet and conquer any vessel of her class; and, therewith, the more coal endurance, the better. It will be seen at once, therefore, that any scheme that requires the weight of auxiliaries to be multiplied by three is entirely inadmissible.

There has not yet been sufficient experience with steam turbines to warrant taking the long step of fitting out so extensive and important a part of the ship's machinery entirely with them; and, at the best, their use would reduce the total weight of electric auxiliaries to only about 160 tons,—an amount still too great.

We are driven, therefore, irresistibly, to the conclusion that, although electric auxiliaries offer very many advantages, their great cost and the amount of space they would occupy render a complete installation of them of doubtful benefit, while their great weight makes it absolutely out of the question. It is to be expected, therefore, that the present mixed system of power distribution will continue aboard ship, possibly as long as the steam engine remains the prime mover, but not that electrical appliances will never occupy a more important place there. On the contrary, there is every reason to expect that, with continued progress, both of makers and users of electric machinery, it will gradually be more and more adopted aboard ship for purposes for which it is peculiarly fitted. The necessary power will probably be furnished by a gradual expansion of the present electric-light plant to meet the new demands. What the limit will be depends upon the future improvement in electrical appliances, especially in the matter of weight.

The thanks of the author are due the Bullock Electric Manufacturing Company for data kindly furnished him.

TANK IRRIGATION IN CENTRAL INDIA.

By G. Palmer.

A FORMER article reviewed the general climatic conditions prevailing in the Hyderabad State, the relations of administration to agriculture, and the arrangement of a typical series of tanks. It remains to consider the actual design, construction, and maintenance, of the works, and the revenue derivable from them; and, in this connection, whether or no a tank is one of a series, we may, in considering its method of construction, treat it as a unit by itself.

The method of constructing a tank is extremely simple. It consists in throwing an earthen dam or "bund," as it is usually called, across a valley, the site for the work being selected after due consideration of the following points:

1. Whether the bund will be in such a position as to intercept the drainage of a sufficient area of country to ensure, even in a bad monsoon, the filling of the tank.

2. Whether the general fall of the valley, and the slopes of the sides at the site proposed, are suitable to produce a spread of surface —with a convenient depth of water—that will allow the quantity required to be stored at a reasonable cost.

3. Whether in the valley immediately below the bund, or within such a distance from it as will not entail the construction of unduly long channels, there exists a sufficient area of ground suitable for the production of irrigated crops and for utilising the whole of the water that the tank is capable of storing.

4. Whether the assessment that can be imposed upon the land irrigated will be sufficient, after meeting the expenses of maintaining the tank and its main channels, to pay a fair return on the outlay in constructing the tank.

5. Whether suitable sites can be found, preferably at either or both ends of the bund, for the construction of strong masonry weirs of sufficient length, over which surplus water can flow away after the level of the water in the tank has risen to that of the crests of the weirs, and whether, after passing the weirs, the surplus water can easily be trained back into the natural stream without damaging the bund or injuring the cultivated area.

6. Whether suitable earth can be found in the immediate neighborhood for the construction of the bund, stone for the construction of the weirs and sluices, and good limestone for mortar. The ques-

tion of material is an important one, as means of communication are bad, and many sites are far from main roads, the only means of carriage being the roughly-made, two-wheeled, springless cart of the country, drawn by a pair of small bullocks.

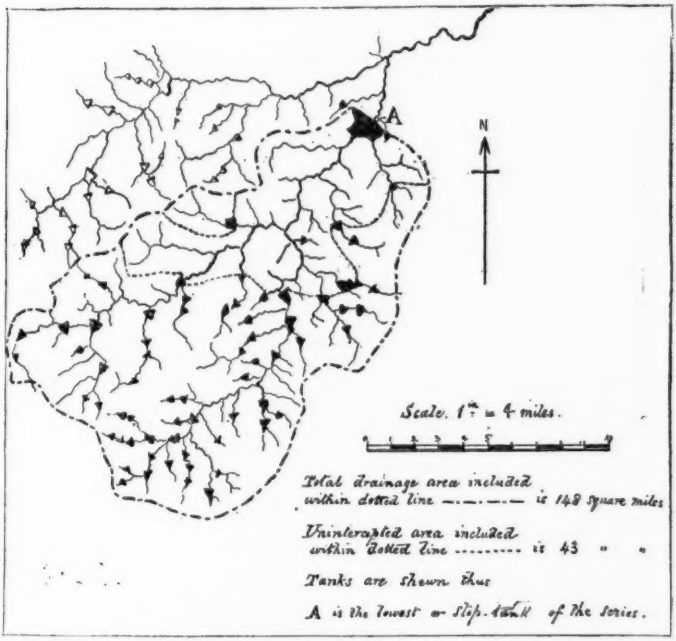
7. Whether the population of the district is sufficient to take up the new cultivation, and whether the people are inclined to do so.

With all the above points duly considered, the ideal bund is that whose length and bulk bear the smallest proportion to the area of the tank formed.

As regards the position of the dam with reference to the drainage area from which the tank will be supplied, and to the cultivable area below (points 1 and 3). This is a question that covers so wide an area that it can be dealt with in practice only by the consideration of each case on its own merits. Thousands of little tanks, or "koontas," were built in olden times by small landholders when the drainage area was below two square miles. It must be remembered that, in a country like the Deccan, where the whole of the available rain-supply falls within four months, where the total annual fall varies considerably, and where the quantity available in any season depends largely upon whether a few heavy falls, such as those exceeding 1½ inches in 24 hours, occur at a suitable time, or whether only light, drizzling rains prevail, a much larger drainage area is necessary to secure a given quantity than would suffice in a country when the fall is more uniformly spread over the whole rainy season, or even over the whole year; and again that irrigation works on the tank system are not constructed with the same regard to the impermeability of the dams, or of the soil on which they stand, that is shown in works designed for a town supply.

As to the proportion of rain that may be expected to flow off the drainage area, the conditions of soil, degrees of slope, and variations in rain-fall, are so numerous that it is difficult to approach a definite rule. A very good authority has given: from .8 of the total fall for mountain slopes or steep rocky hills, to .45 for flat cultivated lands. In the Deccan it is probable that .6 for hilly country to .1 for flat lands may be nearer the mark. The usual allowance is that a cubic yard of water stored will irrigate, including due provision for evaporation and absorption, a square yard of rice cultivation. A drainage area of two square miles may, therefore, with a rainfall of 30 inches in the year, be expected to supply sufficient water to irrigate from 107 to 640 acres of rice, according to the nature of the country. Off some of this area two crops may be obtained in the year, when the total irrigated area will be proportionately reduced.

Tanks with small drainage areas are found only singly and across small tributary streams, or as the top tanks of series. Proceeding


A
N
Scale. 1" = 4 miles.
Total drainage area included within dotted line —.—.—.— is 148 Square miles
Uninterrupted area included within dotted line ..... is 43 " "
Tanks are shewn thus
A is the lowest or Stop-tank of the series.

A TYPICAL SYSTEM OF IRRIGATION TANKS.

down a series, we find the next tank at a distance of perhaps a mile, and the drainage area considerably increased beyond that of the tank above, including, as it does, the drainage area of the former, and so on to other tanks across the same stream, until the tributary joins a larger river. See map.

It is difficult also to fix by rule the amount of water that a tank should be constructed to hold. Experience can but propound a rule of thumb, say, that a tank may be constructed to contain 1½ inches of water flowing off each square mile of unintercepted drainage area, and half that quantity for each square mile of intercepted area, sufficient to irrigate, per mile of drainage area, 27 acres in the former case and 13½ acres in the latter.

The lower tanks in a series catch the surplus water from those above, and therefore, till the bottom or stop tank is filled, no water runs quite to waste. Irrigation goes on from the commencement of one monsoon till nearly the commencement of the next. In an ideal season the monsoon months (June to October, inclusive) provide

sufficient rain, collected in and drawn from the tank, for the first, or the "Abi," crop, while at the end of that period the tank is left full to provide for the second, or "Tabi," crop. The most important question in the construction of tanks perhaps is that of the provision of sufficient length of weir to guard against damage to the work from possible excess of flood. This, in the case of an important tank, is no light task. Bye-washes, whereby surplus water can be trained off without flowing into the tank at all, are not in vogue, and their cost in most cases is prohibitive. All the water from the drainage area must flow into the tank, and the surplus must flow over a weir sufficiently wide to prevent the water from topping the earthen bund. The width of weir necessary is easily calculated by ordinary hydraulic formulæ, after deciding what the maximum discharge is likely to be. For this the formula usually employed in the Deccan is that adopted in the Madras presidency by Col. Ryves:

$$D = CM^{\frac{2}{3}} - cm^{\frac{2}{3}}$$

where D is the maximum discharge from the drainage area in cubic feet per second, C is a coefficient varying from 450 to 750, according to the slope of the country, and the amount of rainfall, M is the whole drainage area of the tank in square miles, including the drainage areas of the tanks, above which surplus into the tank, c is a coefficient which may generally be taken as 100, and m is the intercepted drainage area of the tank in square miles,—*i. e.*, the drainage areas of the tanks above.

For country such as mostly prevails in the irrigation districts of Hyderabad, C may usually be taken as 600, except in places near hills where the rainfall is heavy and the gathering rapid, in which case the coefficient should be increased towards 750, according to the discretion of the engineer.

In the case of a tank with a drainage area of 20 square miles, 10 of which are intercepted, this formula would allow for a rainfall of 7·34 inches over the whole area in twenty-four hours, all running off.

The formula may be considered to give the maximum discharge likely ever to take place, from a given drainage area, in cubic feet per second. If applied to each tank in a series, and if the necessary width of weir be adopted in each case, the whole series may be considered as safe from breaching by excess of flood as human forethought can be expected to make it. Occasions arise, however, when the most liberal provision is found insufficient, and it is on record that on two occasions within four years, in the Yelgundul district, heavy falls of rain, of 10 inches in 13 hours and 12 inches

VIEW OF A TANK (JULPULLY), THE BUND BEING UNDER THE CROSS MARK.
The tank, as shown, is partly empty; when full, the water spreads to the stones in the immediate foreground.

A CALINGULAH, OR ESCAPE WEIR, TO A TANK.

The line is shown by the row of vertical stones. The tank, which is out of sight from this point of view, has a water-spread of about one square mile, an average depth of nine feet, and an intercepted drainage area of about seventy square miles.

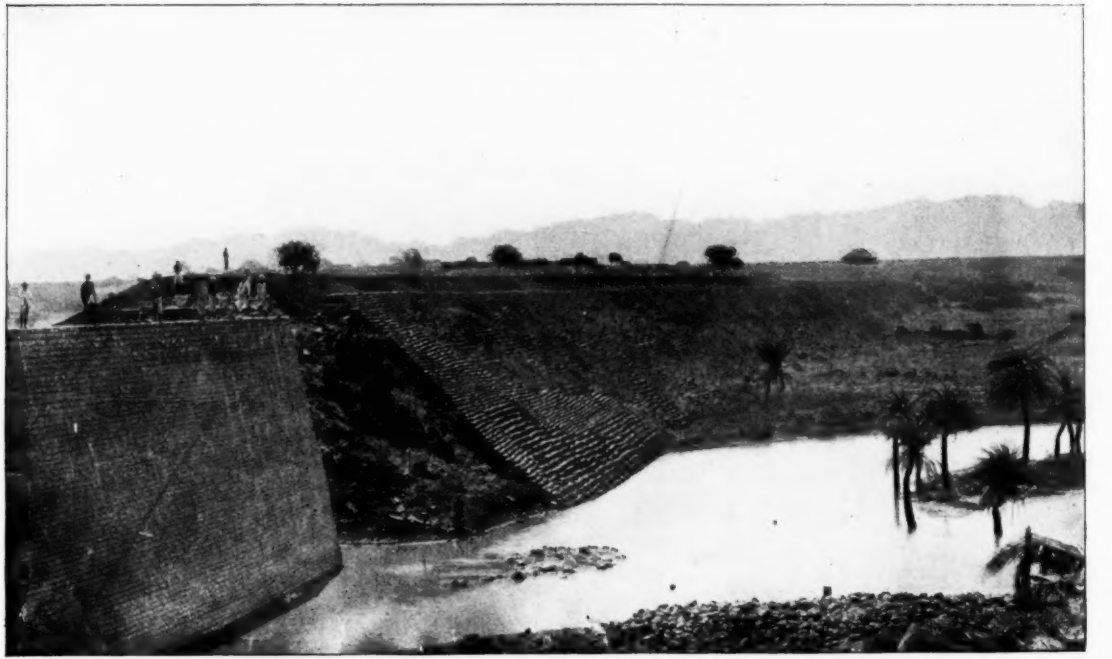
in 11 hours, respectively, occurred, doing immense damage and causing the breaching of nearly 100 tanks in an area of some 1,500 square miles. Many of these tanks, it is true, were not in the best state of repair. It appears, however, that, to resist such a flood as this, each tank bund should be all weir ; but the cost of such structures, in view of the revenue derivable, would be considered by the government quite prohibitive.

The weirs, or "calingulahs," as they are called, are usually masonry walls, of sufficient thickness to resist by their weight the pressure of the water against them when flowing at least four feet over the top. The height to which the top of the bund is raised above the crest of the weir should never be less than six feet, though, to save cost, a height of four feet is sometimes adopted in small tanks. In large tanks, commanding, say, more than twenty-five square miles of drainage area, a height of nine feet is advisable. The water must never be allowed to top the bund, and, where the area of water-spread is extensive, the large waves raised by the monsoon winds must be guarded against ; hence a height of bund which at first seems excessive proves economical in the long run.

Weirs may be provided with sluices, or openings closed by planks, or shutters of wood or iron of a simple form ; in the case of tanks that are constantly under intelligent supervision, the level of the full tank—*i.e.*, the crest of the weir—may by these means be considerably raised. But the majority of tanks are in places where such supervision cannot be had, and where, during the monsoon season, when attention is most required, they are in the charge only of

A DAM, OR ANICUT, ACROSS A RIVER, FOR A SUPPLY CHANNEL TO SEVERAL TANKS.

The river runs from right to left of the picture, and is practically dry in the hot season, when the picture was taken. The dam is built on a ridge of rock crossing the river, which accounts for its irregular line.



THE BUND OF AN OLD BREACHED TANK, BEING RESTORED BY BUILDING A MASONRY WALL ACROSS THE BREACH.
The revetment on the bund is 300-400 years old ; it was laid with unusual care and regularity.

ignorant native cultivators, who are too anxious to secure an extra supply of water without consideration of risk to the safety of the tank, and who are seldom controlled in this respect by subordinate revenue officers who share this motive.

In old tanks it is often found that vertical stones of a height of from two to four feet are placed about three feet apart along the crest of a weir, their object being to enable the cultivators to dam up the water in the tank by means of logs, brushwood, clods, etc., held in place by these posts, to a height beyond that allowed by the solid portion of the weir. This is done towards the end of the monsoon, to retain the water brought in by the last rains; but till the end of November there is no predicting with certainty that a sudden and heavy flood will not come, and the extra dam cannot be moved in time to prevent the bursting of a large and profitable tank. Temporary dams, moreover, even when they have proved successful, are liable to be left till the next season, when the regular monsoon floods may at any time practically demonstrate the risk they cause. Therefore it is advisable to fix the full level of the tank, and build a solid weir with a smooth and level crest to that level, and offer no facility for raising it. The width of the weir is usually calculated to allow a maximum flow of three feet over it. This, when the above-quoted formula is employed, should be sufficient to cope with the heaviest rain-falls, but, with the top of the bund six feet above the crest, there is still a large margin to meet very exceptional floods. The weirs with their wing-walls are usually built of rubble gneiss (a stone very plentiful throughout the irrigation districts), set in good mortar (limestone "kunkur" also abounding).

It is necessary, of course, to choose the site for the weir with reference to the height to which it will have to be built in any part, both on account of cost and on account of the scour of the falling water. To meet the latter, rubble aprons, water-cushions, or ogee falls are adopted.

A weir with its crest not more than one foot above the natural surface of the ground is the most advantageous, if too much excavation is not required in forming sufficient approach for the water.

The bund is usually constructed of the earth found in the locality, specifications always providing that it shall be raised in layers not exceeding one foot in thickness, that clods shall be broken, and that each layer shall be thoroughly well rammed with round-ended wooden rammers before the next layer is imposed.

At the site of the crossing of the natural stream, and when a tank is to be restored by filling old breaches, walls of puddled clay are built in the centre of the dam, of a bottom thickness of six to twelve

EXCAVATING A FEEDER CHANNEL TO A TANK.

Coolies are at work in the bottom of the cutting; women, standing on roughly-cut steps to the right, pass up the spoil in small baskets.

feet, according to the height, and tapering up to two or three feet at the top.

Thoroughly impermeable clay, however, is not to be found in the Deccan, and therefore the best material at hand has to be utilised. The slopes of the bund are usually 2 to 1 on each side, increasing to 3 or 4 to 1 when old breaches are filled. It is necessary to protect the water slope to within three feet of the top by well-packed dry stone rubble as revetment, to prevent erosion of the earth-work by waves. The width of the top of the bund should never be less than six feet, a useful rule being to fix it at about twice the square root of the height. Where it is convenient to construct a roadway along the bund, it is an advantage to do so, as the maintenance of the road insures the keeping of the bund to its proper height.

The water is supplied for cultivation through masonry tunnels crossing underneath the bund. It is needless to say that the foundations of these must rest in the natural earth, and not in the made earth of the bund. At the tank end of the tunnel is the sluice-head, which, in the form of a rectangular tower, projects by steps into the tank. The steps are three or four feet high, and each consists of a flat stone with a round hole, six to nine inches in diameter, in its centre. In these holes are fitted wooden plugs, movable by means of wooden rods. The water is allowed to fall into the tunnel through the highest plug-hole covered by the water.

The sluice tunnels are situated according to the levels of the ground to be cultivated. In the best tanks there is one near each end of the bund, to command the highest ground on each side of the valley. Usually one sluice near the middle or deepest part of the bund will supply the low ground in the centre of the valley, when the level of the water in the tank is too low to enable the end sluices to be used. It is a common practice, but one to be strongly condemned, to construct a masonry cistern at the tail end of a tunnel, to allow the water to rise a few feet and thereby command some ground higher than the level of the tunnel admits of. This causes pressure of water inside the tunnel, which, discovering any weak point in the masonry, will produce a leak that may result in serious mischief to the bund.

This necessarily brief article shows a "tank" to be but a primitive form of work, scarcely worthy of a place alongside the well-constructed reservoirs that supply the towns and manufacturing industries of the west, but this primitive form is due, as already indicated, to the conditions of the country, where all such works must be left, for months at a time,—and those the most important months of their utility,—in the hands of ignorant and unskilled cultivators. There is no reason why this state of things should always continue, and, were the govern-

ment to increase expenditure in improving the works, either from government funds or by the encouragement of private enterprise, and were it to appoint an increased and competent establishment of officials under sound professional control, the scope of tank irrigation might be enormously extended, a safe and sure increase of revenue obtained, and the ills of famine and distress greatly reduced. The following figures show the revenue derived by the government from tank irrigation, and the important position it holds in the industries of the State.

The extent of land cultivated, or that on which an assessment is levied, exceeds 14,000,000 acres,—nearly 22,000 square miles. The population, at the census of 1891, was 11,537,040, or 139½ per square mile of the total area of the State, and 522 per square mile of cultivated land. The latest estimated revenue of the country is 30,280,000 Hyderabad or Halli Sicca rupees.

The value of the Hyderabad rupee is about 20 per cent. less than that of the rupee of British India. If the latter be taken as equivalent to 1s. 3d. of English money, the former is worth one shilling. The land revenue may be assumed as representing two-thirds of the total revenue, and as amounting, therefore, to R20,186,666, or £1,009,333 per annum, in which case the average revenue per acre assessed is 1s. 5.3d. Of the total acreage assessed 95½ per cent. may be considered as "dry," and 4½ per cent. as "wet," cultivation, but of the total assessment 28 per cent. represents the value of the wet lands against 72 per cent. for the dry.

There are, then, 13,370,000 acres of dry cultivation, realising £726,720, or 1s. 1d. per acre, and 630,000 acres of wet cultivation, realising £282,613, or 9s. per acre.

The outlay by the government in maintaining irrigation works during the last ten years has not exceeded 10 lakhs, or £50,000, per annum. This leaves a balance to revenue of £232,613. It would be very difficult to arrive at the capital value of the works producing this income, as many of them have existed for centuries, and the efforts of the irrigation branch of the public works department in the Hyderabad State, since its establishment some twenty-five years ago, have been devoted more to the restoration and development of old works than to the construction of new; but it may be assumed that money judiciously invested in irrigation works should, with competent management, easily realise from 10 to 15 per cent.

The value of the country as a field for private enterprise depends upon the terms that an individual or a company is able to make with H. H. the Nizam's government. Many political considerations come in. As regards land and water for irrigation works, there is plenty of both for extensive developments.

REVIEW OF THE ENGINEERING PRESS

The Wastefulness of Auxiliary Machinery.

ONE of the most valuable contributions to the literature of marine engineering which has been made for some time is the prize essay of the American Society of Naval Engineers upon the subject of the steam-consumption of the main and auxiliary machinery of the U. S. S. Minneapolis, written by Passed Assistant Engineer W. W. White, U. S. N., and published in the *Journal* of the society.

Since the Minneapolis is one of the latest and finest of the cruisers of the United States navy, it may fairly be assumed that the machinery tested represents the highest state of the art of marine and naval engineering practice, and the completeness of the tests, especially in regard to the hitherto much neglected matter of the auxiliary machinery, renders the paper of especial interest.

The methods employed were such as to include all the steam which passed through the engines, those of the auxiliary machinery being made by condensing all the exhaust steam and weighing the water thus obtained. For the main engines a similar course was followed, except that the condensed steam was measured in tanks; thus the figures give the actual consumption, careful calibrations having made corrections for all leakages properly applicable. Results obtained in this manner must obviously be larger than those deduced from the indicator cards, but, as all the machinery was tested on the same basis, the results are properly comparable, and are also more instructive than might have been the case with computed water rates.

The steam-consumption of the main triple-expansion steam engines was about 20½ pounds per h. p. per hour, which is very fair when it is considered that this includes all the condensed steam which actually passed through the engines, under the conditions of regular sea service.

When we come to compare the performance of the auxiliaries with these figures, we see at once what a jump in consumption there is. The most economical machine in the whole list was one of the circulating pumps, which required 55 pounds of steam per h. p. per hour, while more than one-third of the 31 machines tested showed a steam-consumption of more than 100 pounds per h. p. per hour, and four of these passed the 200-pound mark.

Of course, it must not be forgotten that most of these machines were of small power, from which a high steam economy was not to be expected, but in many cases the causes of the waste could clearly be accounted for on other grounds. Thus, in the case of the dynamo engines, the substitution of snap packing rings for water packing grooves in the pistons reduced the steam-consumption from 123 pounds to 68 pounds per hour, while in the case of a steam pump which showed a steam-consumption of more than 200 pounds, the average stroke was only 7½ inches, when it should have been 10 inches, thus giving an excessive and unnecessary clearance.

Probably nearly all the excessive wastes over and above the necessary steam-consumptions of engines of these small sizes —*i. e.*, from 1 to 30 h. p.—were due to one or more of three causes,—leakage, incomplete strokes causing excessive clearance, and absence of expansion,—while to all of these must be added the fact that the heat from the exhaust of the auxiliaries is not returned to the boilers, but passes into the sea with the circulating water of the condensers.

Not only is the relative steam-consumption of the auxiliaries an unnecessarily large quantity, but the total is a large proportion of the entire consumption of the ship's machinery. Taking the run of the Minneapolis from Gibraltar to League Island, which was seven days in duration, Mr. White estimates the average weight

of steam used by the main engines per hour at 33,621 pounds, and that required for the auxiliaries at 10,147 pounds, or 23 per cent. of the whole; so that the wastes not only are relative, but concern nearly one-fourth of the whole quantity of steam supplied by the boilers.

Several methods have been proposed whereby to reduce these wastes and secure an economy for the auxiliary machinery as high, or nearly so, as that of the main engines. It is hardly possible to do this with a number of small machines, although there is room for much improvement, even with the present general arrangement of auxiliaries. It is probable, however, that some form of central power plant large enough to permit the use of economical multiple-expansion engines, and using hydraulic, pneumatic, or electrical transmission, will be the solution of the problem. Electricity is especially adapted for this purpose, as it would also do away with much of the complicated piping systems now necessary for the conveyance of steam to the small engines; and the experience now available in connection with electrical transmission in stationary plants should make such adaptation to marine and naval practice practicable.

The wastefulness of small auxiliary machinery is not confined to marine service, and doubtless tests of many stationary power-houses would reveal as great wastes as those shown in the tests of the Minneapolis. Efficiency in other directions is now the order of the day, and the turn of economical improvement in auxiliary machinery may now come in more directions than one.

Remodeling Machine Shops.

EVERY one knows how inconvenient and unsatisfactory many old machine shops become as they grow in obedience to the demands of an increasing business, when there is no especial care taken to remodel the plant from time to time and keep it up to date. In many instances a convenient arrangement, and proper operative facilities, make all the difference between profit and loss; and in other cases leaks and losses are discovered which were previously not even suspected.

An interesting article by Mr. W. S. Rogers, in *Machinery*, gives an account of the remodeling of an old factory, with what is usually somewhat difficult to obtain,—the cost of making the change and the general details adopted.

Of course no two cases are alike in detail, but there is a general family resemblance between old or badly-arranged machine shops, and Mr. Rogers's picture of the establishment before he undertook the reorganization has many points about it familiar to those who have had the opportunity of visiting, or even working in, certain establishments that might be named.

The account of the manner in which wasteful methods were stopped, order created out of chaos, and an economical and modern shop system introduced, shows that all that is required is a fair stock of that most uncommon article known as "common sense," plenty of determination, and some knowledge of what a good machine shop ought to be. Any man who is possessed of these minor qualifications should undoubtedly read Mr. Rogers's article carefully, and then promptly go and do likewise.

One of the most interesting features of the paper is found in the reproduction of two pairs of indicator diagrams, which speak for themselves, and show how much was saved in power by replacing mule pulleys with direct transmission, throwing aside defective old belting, and dispensing with useless pulleys and shafting.

A machine shop may be remodeled in one of two ways,—either by stopping outright, involving a cessation of output, or, less rapidly, by continuing productive work, and changing one portion at a time. The latter method was adopted in the instance described by Mr. Rogers, and the result was a cost of about $4,000 for time and material, resulting, in one year, in a gain, taken from premiums and time cards, of $4,348.

"Twelve mule pulleys and 110 feet of shafting were thrown out. The fourth and fifth floors were used for storage of

finished product, being a clear gain of 3,200 square feet. Machines that before required a month to build can now be completed in ten days, easily. Others that required two weeks' time are now completed in one; work in the 42-inch lathe that formerly required six and seven hours is now done in three and four; the high-priced mechanics that formerly spent their time lifting and lugging work from place to place now spend it in fitting and joining things in place; work that formerly had to be sent to and from different floors is now completed right where the machine is built."

"There are hundreds of plants dying of dry rot from the fear of that bugbear, 'awful expense' in making alterations, when the truth is it is like finding money to do it, and the outlay is more than gained in a twelvemonth. It requires determination of the owners to be superior to all others, and a superintendent or engineer without a particle of sentiment, technical twaddle, or fear, but with a cold-blooded idea of the commercial side of his employer's dollars, and who can make both ends meet with nothing in the middle."

The Sweetwater Dam.

THE Sweetwater dam is well known as one of the boldest and most important engineering structures of its kind in the United States, and the manner in which it stood a test far more severe than its projectors ever contemplated renders it of especial interest.

An illustrated account of the high water in 1895, and the manner in which the structure behaved, is given in the *Engineering Record* with illustrations, the article being prepared by Mr. H. N. Savage, the engineer in charge, and therefore coming with an authority which makes it doubly valuable.

The dam is an arched masonry structure of the following dimensions: height, 90 feet; length on top, 396 feet; length on base across stream, 75 feet; thickness at base, 46 feet; thickness on top, 12 feet.

The plan of the dam is an arch upstream, with a radius of curvature of 222 feet on the face line at the top, and is a monolithic structure of uncoursed rubble masonry laid in Portland cement.

The drainage basin above the dam is 186 square miles in area, and, from observations covering a period of ten years, it was concluded that the maximum flow of the stream might possibly reach 1,500 cubic feet per second; so the waste water way was constructed with a capacity of 1,800 cubic feet per second. In the storm of January, 1895, heavy rains, culminating in a fall of 20 inches in 68 consecutive hours, raised the discharge of the stream to 18,150 cubic feet per second, or a little more than ten times the capacity of the waste weir. The river discharged more than 5,000 cubic feet per second for 40 consecutive hours, the dam being over-topped its entire length throughout this time.

While the dam escaped absolutely uninjured, the rocky sides of the cañon at both ends of the structure were badly eroded, several thousand cubic yards of ledge rock being washed away. The 36-inch steel main pipe which extended from the dam down through the cañon was badly wrecked, several thousand feet being entirely undermined and carried away.

The reconstruction work, which was immediately commenced, not only included the repairs to the wing walls, but also provided much greater waste-water capacity. The number of waste weirs was increased, additional pipe-line connections were made, and a basin dam 15 feet in height and 200 feet in length was constructed across the cañon, concentric with the larger dam and 50 feet below, to form a water-cushion in case the main dam should again be overtopped. The ends of the main dam were also carried back further into the cañon sides, to prevent water from getting around them again. As now repaired, the dam is stronger than ever, and, in addition, it has been increased 5 feet in height, adding 25 per cent. to the storage capacity, making the present capacity 22,221 acre-feet, which is equal to 7,240,980,000 gallons.

The fact that the dam itself sustained no injury by this extraordinary test sustains very fully the theory of the constructor,

Mr. James D. Schuyler. The profile of the dam, while theoretically giving stability by its own gravity, has not a large factor of safety, and, when the reservoir is full, the line of pressure not only falls without the middle third, but reaches nearly the centre of the lower third. The nearly perfect character of the foundation, the monolithic arched form of the structure, and the manner in which it was firmly wedged between the rock-bound walls of the cañon, rendered it practically impossible of destruction by rupture or displacement from water-pressure alone.

As an addendum to Mr. Savage's paper, an abstract is given from Mr. Schuyler's account of the original construction of the dam, taken from his paper contributed to the *Transactions of the American Society of Civil Engineers* at the time the dam was completed, in 1888. There is little doubt that the care which was given to the foundation and the masonry work had much to do with the admirable manner in which the dam withstood the emergency, and the work as described shows the value of care and conscientious supervision in so important a matter.

Incidentally, the account shows how difficult it is to estimate the possible maximum flow of a mountain stream, even when observations of many years are available.

Water-Wheel Governors.

In the use of water power as a source of energy for electric plants the principal obstacle which has been encountered is the difficulty of obtaining that close degree of speed-regulation so essential to the best working of the plant.

An interesting paper upon this subject, read before the electrical section of the Franklin Institute by Mr. Mark A. Replogle, is published in the *Journal of the Franklin Institute*, and some of the points made by him are of undoubted value in connection, not only with the direct subject, but also with the general matter of speed-regulation.

The first point to be considered is the effect of the inertia and momentum of the water, which in long pipe-line transmissions is a very formidable matter, as the case of the Fresno transmission clearly shows. Prompt or sudden changes of flow in such pipe lines are not permissible, if the safety of the installation is a consideration, as the momentum or inertia of the water may cause bursting or collapse, and in some cases the only available method of governing is that of shifting a stream of water on or off the wheel, as power-demands require.

The second factor is the water wheel itself. Its range of speed is from zero to a rate exceeding the spouting velocity due to the head, and it may allow more water to pass through it at under-speed than it does at over-speed, so that an accurate gauging of the water that enters the wheel does not necessarily have anything to do with the speed. The speed of the wheel is the result of quantity of water, combined with pressure on one hand and load of work on the other, and any change in one of these three factors causes a change in the speed. The speed with which the gates are opened or closed affects very materially the action upon the wheel, as a rapid closing causes at first a much greater pressure at the wheel-gate openings, and a consequent increase in the velocity of the water and of the wheel, while a rapid closing produces the opposite effect.

A third factor is the weight of the gates to be operated, as compared with the light valves or cut-off gear of a steam engine. It is a common mistake to underrate the power required for this purpose, and the mechanism for moving the gates of a water wheel is often made too light, and not rigid enough to do the work properly.

The fourth and a very important factor is the action of gravity. The motion which the attraction of gravity has imparted to the water is to be transferred as nearly as possible to the wheel, and, when the load upon the wheel is changed, gravity must have time to adapt itself to the changes which the action of the governing mechanism causes.

The best method of meeting these difficult conditions is to provide a reserve storage capacity by having a sufficiently heavy rotating mass to act as a fly-wheel and sup-

ply or absorb energy in order to allow the change in the load to take place within the desired time-limit and maintain uniform speed within the allowable pre-determined fraction.

"A properly-constructed governor must open the water-wheel gates as fast as gravity can follow up with water—no faster. It must close the gates slow enough to insure safety to the penstocks—no faster. It must be capable of stopping the gates at any degree of opening. It must be endowed with the relay principle, adjusted to coöperate properly with the power storage. It must not be a separate and independent feature of the power plant, but must be made a part of the plant in an intelligent manner, and at best it is only one of the factors in the government of a water-power plant."

"The science of water-power government has not yet reached so great a degree of perfection as the government of steam engines, yet the underlying principles are being carefully studied by engineers, and the time is not far distant when water powers will all be constructed and governed as reliably and successfully as steam plants are; but that time will not come until the same principles are recognized in the former as in the latter."

Building Stones.

IN a recent and valuable paper, read before the mining and metallurgical section of the Franklin Institute, Professor Alexis A. Julien, of Columbia University, discussed the elements of strength in the constitution and structure of building stones, and brought out some points of interest and importance.

Experience has shown that the older methods of testing and selecting stone for building purposes have not been sufficiently satisfactory to be generally relied upon, and the consequence has been a neglect of proper care in this matter, as is evinced by the deplorable results apparent in the speedy injury and mutilation of many great buildings throughout the United States and elsewhere.

Many stones theoretically satisfactory so far as resistance to comprehensive stresses is concerned are quite unsuitable in other respects.

"The strength of a stone is theoretically its power of resistance, not only to compression, but to all tearing asunder of its particles by forces of frost, weathering, etc. Compressive strength and durability, however, are not synonymous, and their approach in the same stone occurs only in certain kinds, and is then largely modified by climate. Nor does the strength of stone depend to much extent upon its actual mineralogical constitution, though there is need of investigation of many physical characteristics of the common minerals in stone."

The chief elements of strength may be concentrated in four classes:

1. Interlockment of grains, of which three stages occur: irregular aggregation, in helter-skelter disorder and with poor consolidation; parallel sorting of grains; and dove-tailing, or interpenetration. The last is most thoroughly effected in the crystalline stones, and on it far more than on the specific gravities of the constituent minerals depends the weight, taken in mass.

2. Coherence between the grains, effected in two ways. First, cementation, mainly of the fragmental stones, by means of various natural cements, the presence of siliceous cement being the reason for the special excellence of certain sandstones. Second, surface or capillary ad hesion between the minute plates and grains, especially in the crystalline rocks. An important distinction must be made between the two classes of voids in a stone, the pores and the cavities, this involving the subject of the different destructive effects of cavities and pores when filled by flakes or films of ice. This question also includes the solubility of stones and their cements in fresh and salt water, upon which there is need of further investigation.

3. Tension among the mineral grains, and the active stresses which survive in stones and affect their strength, of which three classes occur. First, tension produced by crystallization; second, tensions produced by subterranean strain; third,

tensions produced by present physical conditions; all of which may cause a stone to behave very differently from previous specimens examined and tested.

4. Rigidity, or absence of mobility among the grains of a stone. Evidences of internal motion, flexibility, and plasticity in stones may be attributed to three sources. First, cleavage planes of cleavable minerals, particularly mica; second, gliding planes, illustrated by the miniature faults abounding through all varieties of stone; third, the presence of a lubricant, such as oil, bitumen, and especially of water. The influence of water in nearly all stones is most important, and there is need of special methods for determining the strength of wet or moist stones, especially as regards diminution of rigidity from this cause.

Professor Julien's paper will have accomplished much if it only calls attention to the need of some more intelligent methods of selecting stone for building and engineering work, and there should be no real difficulty in establishing proper methods of tests for record and specification purposes, when once the fundamental lines of the work are clearly marked out.

Mining Claims in River Beds.

IN view of the various propositions, broached of late, to dredge streams in gold-bearing regions, material interest attaches to a communication from Dr. R. W. Raymond in the *Engineering and Mining Journal* upon the law as to dredging rivers for gold, this question until now not having come up for adjudication, and there being in consequence no direct precedents.

Starting out with the fundamental propositions that in the United States navigable rivers within a State belong to the State, and that other rivers belong to the United States, Dr. Raymond proceeds:

"The operation of dredging for gold may or may not injure a navigable river, or impede its navigation. If it does neither, I do not see why it may not be freely carried on, so long as the State does not interfere, but subject to the State's interference at any time. Some of the States, I may add, have laws already concerning the mining of river-beds; and all the rest of them would make such laws very promptly, if circumstances should call for them.

"It would be, consequently, an act of folly to commence operations of this kind without some direct authority protecting the enterprise.

"With regard to a stream not navigable, it is a simple question whether that part of its bed is or is not on the public domain. If it is, it can be freely explored by citizens of the United States, and it can be appropriated in placer claims of not more than 20 acres for each individual claimant. An adventurer might 'explore' up and down a river to any extent by dredging, without having made any location, so long as no one else stepped in to make a location. But he could have no rights against a locator; and therefore the only safe basis for his enterprise would be the naming of a regular placer location, within which his operations might have to be ultimately confined.

"Grounds not on the public domain can only be occupied for this purpose by agreement with the State or the private owner. And in no case can the prior rights of a riparian owner, adjacent, above or below, be interfered with. For navigable rivers, navigation is the supreme use; for all others, the supreme use is agriculture."

Steel and Concrete Construction.

THE use of combinations of steel and concrete for arches and similar constructions is well known; and on both sides of the Atlantic the systems of Monier and of Melan have been used and tested.

The results have been sufficiently satisfactory to render desirable the wider application of the principle of combining two widely-different materials into one structure to resist opposing stresses; hence the paper of Mr. George Hill upon "Steel Concrete Construction," presented before the American Society of Civil Engineers, and published in the *Proceedings*, is especially opportune.

This paper treats of a series of tests of

flat slabs of concrete and steel, in which the steel acts entirely in tension, being distributed through the bottom section of the slab, this construction being especially useful in filling between rolled floor beams in steel-building construction. A fireproof combination requiring no arches between beams is thus obtained, and the use of the steel secures a degree of strength amply sufficient for the loads which the floors are called upon to bear.

The steel used in the experiments was in the well-known form of expanded metal, made from high-grade low-carbon bessemer steel, containing 0.008 carbon, and showing a tensile strength of about 65,000 pounds and an elastic limit of 30,000 pounds. The cements were an American Portland and a slag cement, both stone and cinder concretes being tested for spans ranging from 60 to 120 inches.

"Theoretically, the best results are to be obtained from any combination of this character where the entire compression is taken by the concrete, and where the metal employed is so placed as to occupy the position of the extreme fibre on the tension side.

"Theoretically, it is also necessary, in order to develop the full strength of the metal, that it should be held in place by some means possessing greater strength than simple cohesion between the concrete and the steel. The difficulties to be encountered, in making any series of tests for the purpose of determining the laws governing the resistance of such combinations, were known by the fact that no formula had ever been suggested which even approximately accounted for the extremely high resistance of sections put in place in buildings and tested under concentrated loads."

"In building the slabs, the expanded metal was usually put down in single sheets, with the long axis of the mesh at right angles to the beams, and so set as to be well covered by the concrete in the bottom of the slab. The sheets were sometimes lapped and sometimes doubled, and, when this was done, the only tying was that afforded by the concrete."

The testing machine was arranged so as to apply a load upon a piece of yellow pine 3 feet long, 1 foot wide, and 3 inches thick, placed in the centre of the slab, the reaction of the plunger being opposed by two cast-steel wire-rope straps passing around cross beams which ran underneath the supporting beams.

Sixty different tests were made, using different mixtures of concrete and various spans and thicknesses of slabs, the results being very fully tabulated; for this detailed information reference must be had to the original paper, but from these data Mr. Hill has deduced formulæ from which computations for similar slabs may be made.

Making due allowance for the lack of uniformity of some of the tests, the conclusions were that for a fairly well mixed cinder concrete the ultimate compressive strength should be about 400 pounds per square inch, and for a stone or gravel concrete at least 800 pounds per square inch, the tensile strength being taken at one-fifth the compressive resistance. Taking into account the deflections observed in the tests, the author uses as his constants, for safe working stresses of cinder concrete in compression, 75 pounds per square inch, and, for stone concrete in compression, 150 pounds per square inch, which corresponds to a deflection under uniformly-distributed loads of about one-quarter of that required to crack plaster, and to strains of about one-fifth of the elastic limit of the concrete.

As a result of computations from Mr. Hill's formulæ, a table is given of the proper thicknesses of steel-concrete slabs for live loads from 75 to 250 pounds per square foot, from which it appears that for a span of 10 feet a thickness of concrete of 5 inches corresponds to the above stress-limits with a live load of 75 pounds per square foot, while, for a live load of 125 pounds per square foot, a thickness of 7 inches is necessary to insure the same stresses. By the use of these tables, observing the same conditions as to quality of cement and methods of mixing, floor slabs of steel-concrete may be planned with a fair degree of assurance as to the actual margin of safety which will exist for the corresponding loads.

The Analysis of Furnace Gases.

IN determining the efficiency and nature of the combustion which takes place in boiler and other furnaces it has long been recognized that much could be learned from analyses of the discharged gases as they pass through the flue on their way to the chimney. Usually such analyses are made in the chemical laboratory from samples of gas drawn from the flue by water-suction or by a pump, but it is often difficult to be certain that an average sample has been secured, or that all the conditions of average working existed at the time the gas was drawn off.

These defects can best be remedied, and much additional information obtained, by the use of some form of continuous recording apparatus which may at any time be consulted to ascertain the relative proportion of the principal constituents of the discharged products.

One piece of apparatus for continuous examination of furnace gases is the Arndt "Econometer," a full description of which is given in the *Journal of the Franklin Institute*, in connection with the report of the committee on science and the arts. This apparatus continuously weighs the flue gases, the fluctuations in weight indicating the proportion of carbonic acid gas present, from which the efficiency and character of the combustion may simply and readily be deduced.

This weighing of gases is effected in a gas vessel suspended at one end of a balance beam and carefully counter-balanced in such a manner that any change in the weight of the gaseous contents will disturb the equilibrium. The gas vessel is open at the bottom, and a continuous flow of furnace gases passes through, after having been filtered through cotton and dried by calcium chloride. Since carbonic acid is about one-half heavier than air, and since the other constituents, mainly oxygen, nitrogen, and carbonic oxide, approximate the specific gravity of air, it is possible to graduate the pointer of the balance so that it will indicate the percentage of carbonic acid present.

The econometer, however, is not a recording device, but may be compared, rather, to a steam gauge, indicating to the eye the passing variations in the composition of the furnace gases. For recording the composition, including more than one constituent, if so desired, a device known as the Uehling and Steinbart "Composimeter" has been made. This operates upon a different principle from that of weighing, the various gases being absorbed by suitable chemicals and the suction caused by the absorption being used as a measure of the proportion of carbonic acid or other gas present. The measure is the reduction in volume of gases which takes place in a chamber in which two apertures form respectively the inlet and outlet, and through which the gas is drawn by a constant suction. If, from the stream of gas flowing through this chamber, one of the constituents is continuously removed by absorption (such as carbonic acid by caustic alkali), a reduction of volume takes place in the chamber, which causes a corresponding change of suction that acts upon a suitable recording gauge. There seems to be little doubt that the general use of such devices as the econometer or the composimeter will contribute materially toward a general improvement in the performance of coal-burning apparatus, since a defect which can be located is well on the way to be remedied, and nothing so much contributes to the efficiency of employees as an automatic, mechanical record of the results of their work.

Nelson W. Perry.

THE death of Mr. Nelson W. Perry, which has been referred to with feeling throughout the technical press, touches this magazine closely on account of his long and close relation as contributor and adviser. Mr. Perry was a graduate of Columbia School of Mines, a member of the Institute of Mining Engineers and the American Society of Mechanical Engineers and of the Chemical Societies of Berlin and Paris. Latterly he devoted his attention to electricity, and was editorially connected with *Electricity* and the *Electrical World*.

THE ENGINEERING MAGAZINE joins the many friends who mourn his loss.

THE BRITISH PRESS

Technical Education.

THE remarks of Professor Ayrton at the time of the awarding of prizes at the Coventry Technical Institute, published in the *Electrical Engineer*, contain words so wise and important that, in spite of the well-worn condition of the subject, we feel that a repetition here will be acceptable. Speaking as he did at a technical school, reference to manual training was inevitable, and Professor Ayrton made some points not usually heard on such occasions. Instead of a technical training becoming too practical, as many have feared, he thinks there is a risk of its becoming too theoretical. When a technical teacher has to spend the greater part of his time in giving out information, he has but little left to take any in, and he thereby runs the risk of losing touch with his trade or profession. His so-called practical teaching may then easily become unpractical and untechnical, academic, stereotyped, and only distantly related to industry.

In regard to the use of machinery and the too-common feeling among workmen that labour-saving tools are an injury to the manual workman, Professor Ayrton spoke of the fallacy of such views, and said that the feeling prevalent at the beginning of the century, and still held by many, is the misguided notion that the amount of work to be done in the world is a fixed quantity, instead of varying with the demand and supply, and, therefore, that it ought to be parcelled out like food among a shipwrecked crew.

The mere fact that wages are highest and the standard of comfort in living best in those places where the most efficient and most highly-organised machinery is in use is a sufficient refutation of this mistaken position.

It is refreshing, also, to hear outspoken utterance about the minor importance of prizes and set examinations.

"We all like to come out well in examinations, to be awarded prizes, and to win the approbation of our relations and friends. And this desire to stand high in the examination list undoubtedly furnishes a keen incentive to many young people to work hard. It should be, however, a consolation to those who do not shine in the examination room, but who yet feel that they have got something in them, to remember that success in life is not attained by supplying written answers to a series of questions."

It was Dr. Oliver Wendell Holmes, we believe, who remarked that he did not believe that there was a member of the faculty of Harvard University who could pass the admittance examination to the freshman class without previous preparation; and Professor Ayrton practically admits the same thing when he says that he frequently sets himself a question and then gives himself but a low mark for the inadequate character of the answer which he is able to give, and that, too, in the subject which is his chosen specialty and upon which he is considered an authority.

It is easy to test the ability of the student to give written answers to set questions upon definite subjects. "But it is far less easy for an examiner to assign marks for a student's force of character, for his power to overcome previously-unforeseen difficulties, for his coolness under trying conditions, for his quickness in observing a small effect on which large issues may depend, for his good presence and power of impressing his fellow-men, etc. And yet all these qualities are of enormous value in real life.

"The moral then seems to be for the methods taught at a technical school to be kept well up to date, and for its students to do their best to excel in them, ever striving to increase their stock of those all important characteristics—alertness, thoroughness, and truthfulness—not merely in word, but also in work at the bench, the forge, and the vise,—the truthfulness which is the slayer of shoddyism."

Photo-Surveying.

THE use of the photographic camera as a surveying instrument is by no means new, and is, indeed, the natural outgrowth of the applications of its predecessor, the camera-obscura, in similar lines of work. It has taken the gradual improvement in lens construction, as well as the application of suitable auxiliary apparatus, to make the photographic surveying camera an instrument of sufficient precision to rank with the level and the transit, but now, especially for preliminary and exploration work, the photographic method must be accepted as possessing many advantages.

A paper upon the subject recently read before the Institution of Engineers and Shipbuilders, in Scotland, by Professor E. J. Mills, gives the present status of the method, with descriptions of the latest forms of instruments, and some interesting examples of their application.

The earliest work done in this way was probably that of Laussedat, who completed a photographic survey of Paris in 1861, followed by others in Grenoble and in Savoy; the latter, completed in 1867, extended over 2 1-2 square miles, with a very considerable range in height. Similar work has been done in Germany, Italy, and Austria, but the most extensive photographic surveys have been made in Canada.

"In 1892 an international commission was appointed to examine the boundary between Canada and the United States territory of Alaska. Mr. W. F. King, the Canadian commissioner, carried out his share of the work photographically; and it is stated that in 1893-94 his parties surveyed about 14,000 square miles. Mr. E. Deville, the present surveyor of Dominion lands, has done much work of this kind in the Rocky mountains. Surveyors are under a considerable debt to him for his very able treatises (1889, 1895) on the subject. Deville finds the cost of the camera method to be about one-third of that used in ordinary surveying, and adds: 'Properly used, it gives results far beyond what can be accomplished by any other process.'

"Since the time of Laussedat's early work, the improvements in apparatus have chiefly been matters of detail. Rectilinear lenses and backed gelatine plates are now always employed, and, for a distant work, isochromatic plates. Even very distant objects can now be brought under examination by means of the telephoto lenses of Dallmeyer and others. Indeed, a modern photo-theodolite possesses every essential of an excellent surveying instrument, with a range of work more extensive than is possessed by any of them."

Professor Mills describes a surveying camera of his own pattern, which practically includes all the essential features for accurate work. The centre of the lens is directly over the axis of the graduated horizontal circle, and a scale and vernier provided, by which the actual focus at any adjustment can be measured. Four teeth are so placed in the back as to mark points upon each negative indicating vertical and horizontal lines passing through the optical centre of the lens, while a graduated ground glass enables the relative positions of points to be seen. Levels are provided, and a compass to assist in placing the instrument. A camera thus equipped is capable of very accurately measuring both horizontal and vertical angles, the tangents of which can be easily obtained by dividing the ground-glass readings by the actual focal length.

The general principles of the method are not different from those used in ordinary angular surveying, except that the measurements are made upon two negatives, or prints, taken from two previously-determined points, and that the laws of perspective must be followed in making the measurements. All computations are, of course, dependent upon the actual focal distance between the centre of the lens and the surface of the negative; hence it is important that this distance should be accurately measured for each focus. Usually a base line is measured, and the camera set up at one end and adjusted to cover at centre a signal at the other station. The circle is then rotated until some well-defined object appears at the centre. The angle of rotation is read off, and a photograph taken "at point." The camera is

then set up at the other end of the base line, and the angle to the same point is observed; here also a photograph is taken. From the negatives thus obtained bromide prints are made, and, if amidol developer is used and the prints are soaked in a 2-per cent. solution of formalin, and dried at a gentle heat, there will not be enough shrinkage to affect the accuracy of the measurements appreciably.

The accuracy of the method may be gathered from the statement that two independent measurements of the height of the flagstaff at Doune Castle above the centre of the lens differed only by about two inches.

An ingenious suggestion is made as to the use of profiles made by this method for earthwork computations. Two contiguous profiles may easily be cut out in cardboard or tin, and set upright against a rectangular background. The interspace may then be filled with clay, or some other plastic material, and this dressed to shape, after which the clay may be transferred to a measuring vessel and its bulk in cubic feet determined. The result multiplied by the cube of the inverse of the scale of the photograph will give the number of cubic feet to be excavated.

Parabolic Reflectors.

IN a paper before the Institution of Electrical Engineers, published in the *Electrical Engineer*, Mr. Sherard Cowper-Coles describes an electrolytic process for the manufacture of parabolic reflectors, which seems likely to come into extensive practical use. At the present time glass mirrors are almost exclusively used for search-light projectors, but the objections to glass, such as weight, fragility, and injury from heat, have led to various attempts to make parabolic mirrors of metal. Spun mirrors are never true, however, and stamped ones have also failed to give satisfaction, while the cost of cast and polished reflectors has prevented their general adoption.

Mr. Cowper-Coles proposes a method which seems free from the objections previously found. It involves the cost of producing a single glass mould which shall be true, after which this true parabolic shape can be reproduced indefinitely at a nominal cost, the surface requiring no after-polishing or truing up.

The glass mould is formed to a true parabolic figure on the outside, and highly polished. On this prepared surface is deposited a coating of metallic silver, which is thrown down chemically on the glass and then polished, so as to ensure the adherence of the copper backing. "The mould thus prepared is placed in a suitable ring and frame, and immersed in an electrolyte of copper, the mould being rotated in a horizontal position, the number of revolutions being about fifteen per minute. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature to 120° F., when the metal reflector will leave the glass mould, due to the unequal expansion of the two. The concave surface of the reflector obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish, and requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal to prevent tarnishing. Palladium is found to answer this purpose best, as a bright coating can be deposited rapidly to any desired thickness; the palladium resists tarnishing and the heat of the arc to a wonderful degree."

The details of the method are very clearly indicated in the original paper, with sketches of the apparatus and practical hints as to the precautions necessary in order to obtain satisfactory results.

Reflectors made in this way have been tested very thoroughly, and found to stand excessive heat without tarnishing. Salt water has been thrown upon them while hot, the water being driven off as steam and a white deposit left on the reflector, which was easily wiped off with a wet cloth.

A feature of the metallic reflector of especial value in military signalling operations is that it cannot be destroyed by

bullets. A reflector recently tested at Portsmouth was perforated by a number of rifle bullets without other injury than the small reduction in the area of the reflecting surface, the beam of light being little affected. A single bullet splinters a glass reflector.

In view of the rapidly-extending use of electric signalling apparatus and the employment of parabolic reflectors in search-light apparatus, this improved method of making accurate and durable mirrors at a commercially satisfactory cost, besides possessing all the advantages of metal over glass, must be regarded as a valuable contribution of applied science to manufactures.

Since the appearance of Mr. Cowper-Coles's paper, Professor Elihu Thomson calls attention to the fact that he made mirrors in identically the same manner many years ago, but in view of the fact that no publicity was given to the process and that Mr. Cowper-Coles undoubtedly re-discovered it in ignorance of the previous work of Professor Thomson, the former is entitled to full credit for the public introduction of the method.

Gas-Engine Research.

ONE of the signs of the increasing interest in the improvement of the gas engine is the fact that a special committee on gas-engine research has been appointed by the Institution of Mechanical Engineers, and the first report of this committee, presented at the recent meeting of the institution by Professor Burstall, and printed in the *Journal of Gas Lighting*, shows evidence of good work.

The plan under which the tests were made consisted in making successive variations in speed, compression, and gas mixture, endeavoring to keep all other conditions as nearly constant as possible, in order that the effects of any given change could be traced to the true cause. By using a special experimental engine, in which special provision had been made for these points, some important and valuable information was obtained.

One question about which much interest is expressed at the present time is the influence which increased compression really has upon the economical working. It is usually assumed that a high economy necessarily results from a high compression, and a large portion of the claim in the matter of economy made for the latest comer into the field of internal combustion motors is based upon the very high compression pressure used. At the same time attempts to increase the compression in some existing engines have not acted to increase the efficiency, but have even caused a diminished economy, and there has been some difference of opinion as to the real relation between compression and economy.

In Professor Burstall's tests there appeared a relation between the mixture of air and gas and the most efficient degree of compression, and it seems probable that the influence of increased compression on economy is due to the fact that weaker charges can be burned completely during the stroke when the compression is high. This quite agrees with the experience of Diesel, who says: "The temperature of ignition is a constant value, and only dependent on the physical qualities of the fuel. It is very low for most fuels, and, the higher the pressure at which ignition is effected, the lower the temperature. On the other hand, the temperature of combustion is a variable value, being dependent on many conditions, especially on the quality of air by which the combustion is maintained, and which, under all circumstances, is higher than the temperature of ignition."

The small engine used in these tests gave a rather low efficiency in all cases, but the economy was distinctly raised by increase of compression, the efficiency being only 12.6 per cent. for a compression of 52 pounds absolute, and reaching 18 per cent. with a compression of 105 pounds.

Several interesting features were brought out in the discussion, especially in connection with the serious action of otherwise minor influences when so small a motor was used for the tests.

Mr. Dugald Clerk showed that the leakage past the indicator piston was sufficient

to affect the result materially. In an engine of this size, with cylinder 6 inches bore by 12 inches stroke, the turning on the indicator to take a card often caused a considerable falling off in speed, while a timing valve in connection with an ignition tube was very severe in its effect. These facts must qualify the conclusions to be drawn from tests with very small engines in extending the reasoning to larger motors. The difference between the leakage by the indicator in a gas engine is very different than with a steam engine. In the former case the mixed gases are leaking away all the time during the compression, before the ignition has occurred, thus rendering the combustion different from what had been intended.

So far as the tests have been conducted, the principal conclusion is that economy depends upon the choice of the correct ratio of air to gas, and that this ratio increases with the compression. The number of experiments is not yet sufficient to determine what this ratio is for any given compression, but further trials are to be made to determine this important point.

The Education of Miners.

As a part of the general interest in technical education aroused of late in connection with the development of foreign competition, the necessity of a higher degree of scientific training for mine workers was discussed by Professor Henry Louis at the recent general meeting of the Federated Institution of Mining Engineers at Newcastle-on-Tyne. The paper contained some points of much value, and drew forth an animated discussion, which in itself should do much to further the cause of better technical training for miners.

Professor Louis drew a distinction between the technical education suitable for a mining engineer, general manager, or viewer, and that suitable for the working miner. The working miner's education should be such as to enable him to rise successively to the positions of subordinate official, under manager, resident manager, and mine captain.

Taking the working miner in England, he should possess at least the rudiments of a good English education before beginning his technical instruction, either on the surface or underground. After his practical training has begun, he should continue his studies in evening classes, extending his knowledge in mathematics, acquiring the rudiments of applied science and mechanics, and finally devoting a considerable portion of two or three years to the theory of mining. With the practical knowledge of mining acquired in his daily work underground, by the time he attains the age of twenty-two or twenty-three he should be ready for his second-class certificate.

"There is scarcely any mining district in Great Britain in which tuition in the subjects comprised in the above outline scheme cannot be obtained; a rather greater difficulty is to be found in the question of examinations. Throughout the mining districts of the country a fair and steadily increasing number of young men is to be found, anxious to take advantage of the educational facilities offered to them.

"But, above all, the point which the writer has more than once had occasion to urge must once again be repeated and emphasised,—that the better education of the working miner is the best possible safeguard against accidents. Fully two-thirds of the annual roll of accidents are preventable, and preventable by the training of the miner in thinking power and in the elementary principles of science. Let it not be thought that too much emphasis is being laid upon the importance of the scientific education of the working miner; the level of technical education needs raising, and it cannot be raised unless all ranks advance proportionately."

Referring to the training of the mining engineer, Professor Louis remarks that, in view of the fact that custom has decided in Great Britain that three years is ample for the scientific training of the mining engineer, the aspirant will have to come to his work exceptionally well prepared.

The necessity for use of the three short years to the best advantage was fully discussed, and the coal mines regulation act criticised as giving too much weight to

time spent about the mine in comparison with that used in acquiring the scientific portion of a mining training.

In view of the criticisms which Professor Louis makes upon the present system, his proposed remedy is of interest. The chief reforms he advocates are the following:

(1) Every manager of a mine, whether coal or metalliferous, to hold a certificate.

(2) Certificates to be granted upon examinations controlled by a central board, making the examination identical in conditions and character for the whole of Great Britain (and, if possible, for the colonies also).

(3) A minimum of scientific training to be insisted on, and residence in a recognised scientific college to count up to, say, one-half of the apprenticeship required. At the same time a minimum of underground training to be also insisted on,—say, three years for each example.

(4) Every mine surveyor to hold a certificate of proficiency.

Professor Louis ventures to think that these suggestions are neither very drastic or very revolutionary, and is convinced that much good would result from their adoption.

The Central London Railway.

THE account in recent issues of *Engineering* concerning the plans for the Central London Railway gives a very excellent description of this important piece of rapid-transit work, and, although the data are in some respects only preliminary, and fuller details are reserved for later publication, a very fair idea of the magnitude and character of the undertaking is obtained.

Owing to the exaggerated valuation placed upon proprietary rights, it was decided to follow the line of public highways, instead of running the tunnel under private property; and the line adopted runs from the Bank along Cheapside, Holborn, Oxford street, Bayswater road, and Uxbridge road, to Shepherd's Bush,—a total distance of about 6½ miles.

The compact bed of clay upon which London is built makes the engineering work of construction comparatively simple, as the boring can be done continuously by use of the Greathead shield, and the completed tunnel lined with cast iron without any disturbance of the upper soil.

The railway will be constructed with two separate tunnels, driven through the clay beneath all pipes, sewers, and other underground work, each tunnel being 11 feet 6 inches in diameter.

The plans provide for trains at 2½-minute intervals, each train consisting of 7 carriages drawn by an electric locomotive and furnishing accommodations for 336 passengers. The full meaning of this will be appreciated when it is remembered that the present train-interval on the Inner Circle is from 5 to 10 minutes.

It is possible here to give only a very general idea of the electrical and mechanical features of the plant; for detailed particulars reference must be had to the longer descriptive articles. The current will be generated in three-phase machines and will pass through rotary converters and drop-down transformers at sub-stations. It will be generated at a pressure of 5,000 volts, and transformed and converted into a direct current of 500 volts before it enters the lines.

The locomotives, of 45 tons' weight, will be similar in appearance to those made for the Baltimore Belt Line of the Baltimore & Ohio Railway, the current being delivered by a third rail and transmitted by a slipper to the locomotive. The distribution of the work was very carefully plotted in diagrams, in order to ascertain the probable demands on the motive power, the closeness of the stations and the high speed between them causing great changes in acceleration and retardation. These inequalities will be partially met by placing each station on a summit, so that the entering trains are retarded and the outgoing trains accelerated by gravity. These resistances, as well as those due to the atmosphere and to friction, are included in the diagrams, and the average power required is thus computed.

The power house is planned to contain

six Reynolds-Corliss cross-compound condensing engines, each coupled direct to one 850-kilowatt three-phase generator. The engines are to run at 94 revolutions per minute, and are 24 and 46 inches bore by 48 inches stroke, indicating 1,300 h. p. The engines are guaranteed for a consumption of 13½ pounds of steam at 1,000 h. p., and the speed variation is not to exceed 1¼ per cent. between minimum and maximum load.

The boiler house is to contain sixteen Babcock & Wilcox boilers, fitted with Vicar's mechanical stokers. Coal being fed by mechanical conveyors from overhead bins, and ashes being removed in a similar manner, the manual labour is reduced to a minimum. Four Barnard cooling towers provide for the removal of the heat from the condensing water, each tower being 14 feet 8½ inches in diameter and 50 feet high—this being by far the largest installation of evaporative condensers in England.

The operations of the road involves also the construction of numerous lifts at the various stations, and an elaborate system of oval subway construction at the Mansion House, which will not only afford easy and convenient access to the City terminus, but also be of much use in facilitating crossing at this crowded spot.

At the present rate of progress it is estimated that about a year will elapse before the road can be opened to the public, but, when completed, one will be able to make the full distance in twenty-five minutes, or go from Oxford Circus to the bank in ten minutes.

The engineering has necessarily been distributed among several specialists, among those entrusted with it being Sir John Fowler and Sir Benjamin Baker, as engineers to the railway, Mr. F. Hudleston, as engineer to the Electric Traction Company, Limited, and especially Mr. H. F. Parshall, by whom the plans for the electric construction were made.

The generators, transformers, and rotary converters are furnished by the British Thomson-Houston Company, and the electric locomotives by the General Electric Company of Schenectady, New York, U.S.A.

Gauging Boiler Furnaces.

THE failure of furnaces of internally-fired boilers is generally preceded by a certain degree of deformation, which, if detected in time, may easily be remedied. Even when it is suspected that the furnace is out of truth, it is by no means easy to determine the extent or direction of the deformation, and so the correction of the defect is difficult.

In a paper recently presented before the North-East Coast Institution of Engineers and Shipbuilders, Mr. T. Messenger described a simple and ingenious apparatus for gauging the circularity of boiler furnaces, which not only indicates the irregularity, but also magnifies it.

Briefly, the apparatus consists of three telescopic legs or rods so arranged that they can be placed in the furnace, radiating from a centre pin, and act as a support for a small board to which a sheet of paper can be attached. A telescopic arm, carried on the centre pin, is arranged so that it can be carried around with a roller at the end in contact with the interior surface of the furnace, at the same time yielding to all the irregularities in its shape. A pencil point attached to this arm near the centre traces a closed figure upon the paper, thus furnishing a graphical record of the entire circumference of the furnace, on a reduced scale as regards diameter, but on a full scale as regards the deviation from true circular form.

While this device, as applied to boiler furnaces, appears to be new, a similar apparatus on a much larger scale was applied a number of years ago in the United States for the purpose of investigating the condition of a large circular brick sewer, a radial arm tracing a reduced outline of the periphery of the sewer upon a sheet of paper held at the centre of the sewer. In this instance the influence of earth pressure upon the exterior of the sewer was clearly indicated, as well as the distortion due to settling and erosion,

The advantage of such a method over that of a mere record of diametral measurements is obvious, and the principle is capable of wide application.

Railway Business in Japan.

IN the course of a series of articles in *The Engineer* upon "Modern Japan," some interesting points are made concerning the development of Japanese railways and the furnishing of equipment and supplies to this important market; and the progress of the Japanese in mechanical and business experience is well indicated.

At present there are about 2,800 miles of Japanese railway in operation, and the reasonably probable extensions that should result from present schemes, exclusive of the lines now open, amount to about 6,500 miles. At an estimated cost of £4,000 per mile, the expenditure on railway construction, should amount to at least £26,000,000.

"A few years ago the railways were more or less under the control of the foreign staff, who had already their fixed notions as to where and how things should be purchased. Such is no longer the case. and now the purchasing is in the hands of Japanese, many of whom have experience and others who have not, but all of whom are thoroughly theoretically trained.

"To treat with such men on the subject of railway requirements it is essential that thoroughly technical men should represent British firms. As matters now stand, it often happens that a travelling tout who hardly knows a machine from a bale of cotton lays down the law about locomotives to Japanese officials who have spent the whole of their lives in studying the subject.

"Twenty years ago a man armed with a catalogue and a certain amount of assurance, but with no technical knowledge at the back of it, could make some headway But now the days have passed when a 'dry-goods man,' whatever that may be, can expect to do much in the way of selling machinery in Japan. The Americans have realised this, and employ the best men they can lay hands on. It will be policy for British makers to look carefully into this matter, and not necessarily to give their representation to the man who will work for the smallest salary or on the lowest commission,—at all events, where railway materials are concerned."

The Bursting of Copper Pipes.

IN the course of a review of the boiler explosions which occurred during 1897, *The Engineer* discusses the question of copper pipes on shipboard, — a matter which comes up periodically, and which on this occasion is revived because of the accident on the steamship Prodano, where the bursting of a brazed copper pipe caused the death of four persons.

The investigation showed that the pipe burst at the brazed seam, and that, although it had been tested far above the working pressure when it was first put in in 1889, and at reduced pressure several times thereafter, the explosion was due to original defective brazing of the pipe. According to the court, too long a time had been allowed to elapse without subjecting the pipe to a suitable hydraulic test, as by no other process could its condition have been ascertained.

The Engineer calls attention to the fallacy in assuming a test by hydraulic pressure to be a reliable method of detecting weakness in pipes of this sort, or of measuring their full capacity to stand the stresses which may be thrown upon them. The great objection to the hydraulic test is the fact that it may bring about a false sense of security.

Nearly all instances of steam-pipe failures are due to circumstances which no hydraulic test could have indicated.

In many cases there are sudden shocks caused by racing of the engines, or the impact of water-hammer, or cramping strains due to insufficient provision for flexibility; and these causes are sufficient to induce stresses far beyond those produced by the gradual application of internal hydraulic pressure.

The hydraulic test should, indeed, be applied as thoroughly as the board of trade requirements demand, but other things should also be looked after. Automatic drainage should be provided, so that shocks from entrained water could not occur; and the pipes should be so shaped and erected as to insure plenty of flexibility, since it is from the absence of these precautions that most of the serious accidents have occurred.

THE CONTINENTAL PRESS

The Purification of the Seine.

WE referred several months ago in these columns to the important sewer construction works now under execution in Paris. Now we have, in the *Bulletin de la Société d'Encouragement*, a paper by M. G. Bechmann, the chief engineer of the sanitary department of Paris, giving a very full account of the methods and work which have been employed for the protection of the Seine from sewage contamination, and the measures which have been taken to develop the sewage farm system in the vicinity.

The supply of drinking-water for Paris is brought from a distance, and the discharge of sewage into the Seine had no bearing upon that problem; but the foul condition of the river long ago called attention to the necessity of doing something, and in 1855, when the transformation of Paris under the energetic direction of Haussmann was undertaken, measures were taken to prevent the discharge of sewage into the river within the limits of Paris.

This was accomplished by carrying large collecting sewers along each bank of the river to receive the discharges from the sewers which had formerly emptied directly into the stream, these collectors delivering the entire discharge into the Seine at Asnieres, below Paris, the bend of the river making this connection direct and convenient.

So far as the residents of Paris were concerned, this work, which was completed in 1867, was entirely satisfactory, but the increasing foulness of the river below Paris soon called for relief, and, after the troubles of 1870–71 were over, the sewage farms of Gennevilliers were started, and what was formerly a sandy waste was converted into a thriving market garden, while the river was also much improved.

Since then urgent efforts have been made to extend the system, mainly through the efforts of the engineers of Paris, MM. Mille and Durand-Claye, but for a long time there was a most unreasoning opposition among the residents and property-holders of the department of Seine-et-Oise, who feared that their property was to be depreciated by the creation of an offensive nuisance. Prohibitory damages were demanded, and even the local authorities united with mobs to interfere with preliminary surveys; hence it took from 1875 to 1889 to secure the passage of the necessary legislation for the construction of the great sewage works and farms at Achères, now completed.

Owing to the several bends in the Seine, the sewage canal by which the discharge is conducted to Achères crosses the river three times. At Clichy pumping is resorted to, four large centrifugal pumps, with vertical axes, each pump directly connecting to its own Corliss engine, lifting the sewage in order to give sufficient head to enable it to pass through a tunnel under the river. The pumping station is arranged to permit the installation of four additional pumps, which will ultimately provide ample capacity for double the existing requirements. The tunnel is itself an interesting piece of work, having been pierced through the bed of the Seine by means of the Greathead shield system, using compressed air and hydraulic pressure, the finished tunnel being lined with bolted cast-iron sections.

The second crossing of the Seine at Argenteuil is by means of a handsome steel arch aqueduct bridge, a second pumping station at Colombes lifting the flow to the required height, from which the principal aqueduct at Achères conducts and distributes the sewage over the farm territory. A portion of the land at Herblay lying in another bend of the river required a third crossing, which was accomplished by a submerged siphon composed of two riveted steel pipes. This siphon was prepared upon the surface and then sunk to a foundation of piling at the river-

bed, the pipes being bedded and enclosed in concrete.

The completion of this great work practically takes all Paris sewage-discharge from the river and deposits it in a dilute and inoffensive form upon a sandy, gravelly tract, formerly worthless for agricultural purposes, and now rapidly becoming valuable garden land. The water, after it has filtered through the soil, is practically clean and pure, and there is not the slightest objection to its discharge into the river, where it finds its way only by the slow natural process of percolation through the porous soil.

The engineering details of this great work reflect much credit upon M. Bechmann and his assistant, M. Launay, for, although the general plans were executed practically as they had been conceived and arranged by MM. Mille and Durand Claye, many important constructive features had to be devised as the work progressed. The entire operation of the system is even yet not complete, but it is expected that those who visit the exposition of 1900 will find the Seine as free from contamination as if Paris were not situated upon its banks.

Notes on Testing of Materials.

IT has been known for some time that a distinction must be made between real and apparent resistance to tension, the two being by no means always identical. Pieces from the same bar, in metal testing, turned to the same diameter, will give different results in the testing machine, according to the length of the reduced portion or the character of the reduction, and, unless the entire conditions of the test are reproduced, no one can be sure that the results will be repeated. Under these circumstances it is important to investigate the conditions which will indidicate the true strength of a material under test, and this subject is discussed in a paper by Professor C. Bach, read before the *Württembergischen Vereines für Baukunde*, and published in the *Zeitschr. des Vereines deutscher Ingenieure.*

Professor Bach confines himself principally to the testing of cement, and shows how greatly the form of the test specimen may influence the result, together with the reason for such action. The unequal manner in which various portions of a section act to resist tension is shown by an experiment made by Herr Föppl upon a test-piece made of rubber, in the form usually made for cement test briquettes. By taking such a rubber piece and drawing lines upon it with India ink, and then subjecting it to tension, it will be seen, upon examining the curvature which the lines assume, that certain portions are stretched to a greater extent than other parts. In the case of the cement briquette form, it is found that the outer fibres stretched four times as much as the central portion, or twice as much as the mean elongation; so that it is far from the truth to assume that the entire section is uniformly strained, and we are not always justified in dividing the total stress by the sectional area in order to obtain the stress per unit of section.

Rubber is used to illustrate this action only because of the greater stretch which can be given to it, but Herr Föppl assumes that the distribution of stresses is practically similar in other materials, such as cement, iron, and steel.

It is evident that, if the stress were uniformly distributed over the whole cross-section, the actual resistance would be much greater than when certain portions have to bear an undue proportion, and, according to Föppl, in such cases as the briquette form, a lower strength is indicated by the testing machine than the material really possesses.

It does not follow, however, that this is a general rule, applicable to all kinds of materials. Professor Bach gives examples of a series of tests made upon wrought iron, in which the highest resistance is shown for the shorter specimens, contrary to Föppl's conclusion.

With cast-iron specimens, however, the action is similar to that of the rubber example,—*i. e.*, the test resistance is greater for the long specimen than for the shorter pieces. In both instances also it is necessary to consider the extension, and the reduction of area, which, in the case of wrought iron, is greater for the longer

specimens, while in the case of cast iron there is practically no difference.

Turning now to cement, Professor Bach made comparative tests with specimens of the ordinary briquette form and with the same mixtures in a longer prismatic form, the cross-sections being identical, and the results showed the reverse of what the deduction from the rubber model indicated, the longer specimens having a much lower strength than the short briquettes. This he considers partly due to the fact that it is not practicable to secure as homogeneous a mixture and as thorough hardening with long specimens as with shorter ones,—a view which is borne out by the fact that test specimens of large diameter give lower results per unit of area than smaller diameters. Even with the greatest care in mixing and incorporating the materials, Professor Bach maintains, it is not wise to assume that large masses of cement have as great strength as that shown by smaller test specimens.

For this reason it is never wise to assume that any cement mortar may safely be subjected to a greater tensional stress than that indicated by tests upon standard briquette specimens; on the contrary, it is advisable to assume that in practice a lower strength will exist than that shown by the test.

While it is not safe to draw conclusions as to the magnitude of stresses from the behaviour of rubber specimens, much may be learned from them as to the direction and nature of the deformations caused in other and more rigid materials.

The Measurement of Flowing Water.

FROM the earliest times the measurement of the flow of water has been considered one of the most important of engineering problems, and, in one shape or another, it has occupied the attention of eminent engineers of all countries.

It is only within comparatively recent years, however, that the great influence exerted by the nature and condition of the surface of the channel has been appreciated, and since 1850 the experiments originated by Darcy and continued and expanded by Bazin have had a profound influence upon the labors of hydraulic engineers who have studied the subject.

The formulas now used owe their form to Darcy, while the experiments of Bazin showed, approximately at least, the allowance to be made for channels of various degrees of roughness.

At the present time, however, the greatly-expanded form of Darcy's formula, due to the industry and ability of Messrs. Ganguillet and Kutter, and known all over the world as "Kutter's formula," is generally considered the most accurate expression from which the mean velocity of a stream of flowing water may be computed, and, notwithstanding its apparent complexity, it is very generally used.

Now, however, we have a new formula, presented by M. Bazin himself, based largely upon the data that were used by Ganguillet and Kutter, with additional experiments included, and from the original memoir contributed by M. Bazin to the *Annales des Ponts et Chaussées* we give an abstract of this important addition to the science of hydraulic engineering.

In reviewing the numerous gaugings upon which the determination of the values for the constants of his formula depended, M. Bazin saw that by no means all were entitled to the same weight. The experiments upon certain classes of small channels were few, but, owing to the care and accuracy with which they were made, were entitled to much greater authority than were the much greater number of observations and gaugings of large streams, in which the same degree of precision could not be expected.

After thus weighing the probable value of each experiment, the result was reduced to the general form adopted, and plotted graphically, so that the whole mass of data was formed into a system of lines, from which the general law could be deduced.

Upon the method adopted in making the gaugings largely depended the importance attached to each series of gaugings used. The uncertainty involved in the use of double floats rendered velocity measurements made in that manner less reli-

able than those made with current meters of the Woltman mill type, since, with the improved instruments of this kind, the various velocities at many points in the same cross-section can readily be determined, and a mean value found.

It was apparent that a coefficient of roughness must still be employed, and, as M. Bazin well remarks, it is in the choice of this coefficient that the judgment and experience of the engineer must appear.

It is impossible here to give the detailed computations by which M. Bazin arrived at the new formula, but we give it as it finally appears, in order that its simplicity, as compared with the preceding formulas, may be seen.

If U be the mean velocity in meters per second, I the slope, and R the hydraulic radius,—*i. e.*, the cross-section divided by the wetted perimeter,—we have:

$$U = \frac{87\sqrt{RI}}{1 + \frac{\gamma}{\sqrt{R}}}$$

in which γ represents the coefficient of roughness, which may be selected from the following table, according to the nature of the walls of the channel:

For very smooth walls, cement, planed boards, etc.	0.06
For fairly smooth planks, brick, dressed stone	0.16
For walls in ashlar masonry	0.46
For walls of an intermediate character, such as regular sections in earth, or with stone embankments	0.85
For canals in earth, under ordinary conditions	1.30
For canals in earth, of unusual resistance, with weeds, etc.	1.75

It is claimed that the new formula is rather more than an empirical rule, and that it contains some features indicating that it may represent some of the characteristics of a truly rational formula.

This will appear from the following considerations. If the cross-section be indefinitely increased, the resistance becomes independent of the nature of the walls—a principle which we might have admitted *a priori*. Moreover, the roughness is no longer defined by two parameters, as in the previous formula of M. Bazin, but by a single constant, γ, which increases with the specific resistance of the bed, and which may properly be called the coefficient of roughness. It is found that the formula represents with a close degree of accuracy not only the data from which it was deduced, but also those measurements to which it has subsequently been applied.

The high reputation which attaches to all the work in hydraulic engineering thus far accomplished by M. Bazin will undoubtedly cause this new formula to be used with reliance by engineers in many countries, and experience should soon confirm the correctness of the deductions which he has so confidently put forth.

Tests of Railway Ballast.

SINCE 1895 an investigation has been conducted by the royal testing laboratory at Berlin upon the relative value of gravel and broken stone as materials for ballast in railway construction, and the report of Professor Rudeloff, by whom the tests have been conducted, is now made public in the transactions of the laboratory.

Several sorts of gravel were included in the tests, and all the material was sampled by passing given weights through sieves of meshes ranging, in six sizes, from 6 to 50 millimeters mesh, or about ¼ inch to 2 inches. The various kinds of gravel varied somewhat in size, but, taking the average,—about 60 per cent.,—ranged between ½ inch and one inch, while fifty per cent. of the broken stone was above the two-inch size.

The materials were subjected to four different kinds of tests: for the resistance to blows of the ramming tool; for the resistance to the wearing and shattering action due to the vibration of the rails under the action of trains; for the resistance to the direct pressure of the loads upon the rails; for the resistance to the disintegrating influences of weather and frost.

In order to be able to measure the effects of these various influences upon the materials, the proportion of the different sizes of stone in each sample was carefully determined in the original state;

and, again sizing the material after testing, the increase in the smaller sizes showed the extent to which the material had suffered by the test.

The tests were made mechanically, so that they could be reproduced exactly for the different materials, thus insuring identical conditions and enabling intelligent comparisons to be made. In the case of the ramming tests, a tool similar to the bar used in actual work, arranged in a machine devised by Professor Martens, acted upon a mass of stone or gravel placed in a box with stout walls, in which the confined material was rammed, tests being made with 100, 300, 600, and 800 blows upon successive boxfuls,—100 blows corresponding to about 1,500 foot-pounds, and the other tests being in proportion.

The action of passing trains over sleepers was reproduced by blows of a drop ram upon a wooden beam resting upon the ballast, three tests being given to each sample, with 500, 1,000, and 1,500 blows; 500 blows equalling about 11,400 foot-pounds.

The tests for resistance to direct pressure were made upon material in the following conditions: entirely dry; soaked with water for two hours; frozen; and wet material which had been frozen and then partially thawed. The ballast for these tests was rammed into a cast-iron pipe, and then subjected to pressures of 20 to 40 tons, in the 100-ton Pohlmeyer testing machine.

The results of these tests are very fully tabulated in Professor Rudeloff's paper, and graphical diagrams are also given, which enable the behaviour of the different kinds of ballast to be understood by inspection. To these tables and diagrams the interested reader must be referred for the details, as we can give here only some of the general conclusions.

The various kinds of gravel showed as great differences in resistance as compared with each other as did the broken stone as compared with the gravels; and one of the gravels—that from the river Eder—gave results almost identical with those given by the broken stone, so far as endurance was concerned. This is especially interesting, since this particular gravel was the one which showed the most general distribution of pebbles of various sizes.

In the matter of resistance to vibration, those gravels which contained the larger pebbles gave the better results, the resistance increasing as the proportion of larger sizes increased; in this respect some of the gravels showed even better results than did the stone ballast.

The general results of all the varied tests, while not altogether harmonious, showed that stone possesses no advantage over well-selected gravel, but that, on the contrary, some gravels show higher resistances under the tests than the rock ballast. In fact, the stone appears to represent very nearly the mean of the results obtained with the six varieties of gravel tested. In the United States stone is sometimes used because of its freedom from dust, and, while this is hardly a mechanical feature, it has much to do with the comfort of passengers, although with it also comes a much greater amount of noise.

While some of the methods of test may not have reproduced the conditions of actual service as faithfully as might be desired, and, while it would have been better to have had as many kinds of stone as gravels, these tests may fairly be considered a valuable contribution to our knowledge of the behaviour of materials of railway construction.

Internal Friction.

AT the international congress of the association for the testing of materials of construction, held in connection with the recent Stockholm exposition, a number of valuable papers were read, some of which have been already reviewed.

An important paper by Professor Rejtö, of Budapest, presented at that time is now reviewed by Professor Kick in the *Zeitschr. des Oesterr. Ingenieur und Architekten Vereines*, and, as the treatment is somewhat novel and interesting, it demands attention.

Professor Rejtö discusses what he terms the internal friction of rigid bodies, par-

ticularly with regard to the action of tools in displacing material, as in the various operations of machining, and considers the manner in which the molecules must act upon each other when cohesion is overcome.

When a specimen of any given material is tested to destruction under compression, the fracture is nearly always of a conical or pyramidal form; or, rather, the mass assumes the shape of two pyramids with their apexes together and their bases at the pressure plates, the material on all sides crushing away under the action of the forces transmitted through the molecules of the body. A similar form of rupture is seen when the chips produced by a planer or shaping machine are examined, these evidently being forced off by what we call the cutting action of the tool. According to Professor Rejtö, the action of the tool is really transmitted to the surface of rupture through the molecules of the material itself, the resistance being opposed by the internal molecular friction; by studying the manner in which pressure is transmitted through a mass composed of spherical particles, he shows how this hypothesis explains the form generally assumed by the ruptured section.

In order to show what he means by the internal friction, and how its value can be determined, Professor Rejtö takes an illustration. If we consider a body subjected to compression between two plates, as the plates approach each other the test specimen becomes shorter, but increases in diameter. Now, the work performed is measured by the product of the internal friction and the increase in diameter, and the force which under tension would produce an extension equal to the increase in diameter gives the value of the internal friction in the case under consideration.

Applying this principle to an analytical and graphical investigation, it is possible to compute coefficients of internal friction, and to classify various materials into groups, according to the constancy of these coefficients. Upon the lines thus marked out, our stock of knowledge concerning the true nature of materials may be decidedly augmented.

Incandescent Lamps.

THE successful introduction of incandescent gas lighting has been followed by a partially successful extension of the method to devices in which the necessary heat is furnished by the combustion of other materials than gas. Some of these lamps use petroleum, sprayed into a vaporizing tube by the action of compressed air, the oil vapor being then burned under a thorium mantle. The blast of heated oil vapor under high pressure produces a most brilliant incandescence. For portable use, however, lamps have been made which require no reservoir of compressed air, and, in a discussion of improvements in illumination by the German Society of Mechanical Engineers, published in *Glaser's Annalen*, some points in regard to the progress of this method of incandescent lighting are brought out.

The lamp most extensively used in Germany is the so-called *spiritus glühlicht*, or spirit incandescent lamp, and, according to Herr Gerdes, the firm of Julius Pintsch has made and put into use about thirty thousand lamps of this character, of various kinds.

The construction of the spirit incandescent lamp has been varied somewhat since its introduction, but the general principle is the same, a wick being used, over which the mantle is placed while the force of the flame is augmented by the blast of vaporized spirit which has passed through a thin tube exposed to the heat of the flame.

In the early forms, these lamps consumed about 150 grammes of spirit per hour, and produced a light of about 50 carcels, corresponding to about 475 c. p. Later improvements, especially with the aim of maintaining a constant level of the spirit and a better construction of burner, have lowered the consumption to 110 grammes per hour, and at the same time increased the illuminating power to 80 carcels, or 760 candles.

The moderate cost in Germany of methylated spirit suitable for use in these lamps makes them more available than in countries where the cost is higher; but

even in Germany the cost of the spirit has led to attempts to make petroleum incandescent lamps. According to Herr Gerdes, however, the firm of Julius Pintsch has not succeeded as yet in making a satisfactory petroleum burner for use with incandescent mantles; in fact, most of the claims made for petroleum incandescent lamps seem to be somewhat tardy of fulfilment, in Germany at least.

This may partially be accounted for by the fact that there is a general desire in Germany to avoid becoming too large a purchaser of petroleum, since this would cause a rise in price which could hardly be resisted, in view of the control of the petroleum market. One of the strongest reasons urged for the development of the spirit incandescent lamps appears to be the desire to become independent of the petroleum monopoly, and in the present temper of Germany against the use of articles controlled in other countries and in favor of advancing home products this factor may become important in the development of the spirit lamp and against the use of petroleum.

A Tunnel Under the Strait of Gibraltar.

A NOTE in a recent issue of *Le Génie Civil* gives an outline of a plan proposed by M. Berlier, (who has already shown his ability in this line by constructing two tunnels under the Seine) for a tunnel under the strait of Gibraltar, connecting Europe with Africa.

A map and a profile show the plans proposed very clearly, and, although the probability that the scheme will ever be executed is very remote, the novelty of the idea renders it worthy of brief notice.

Owing to the depth of water, it is impracticable to consider a tunnel at the narrowest point between the two continents, as the grades of approach would be too great. It is also considered desirable to have the European entrance not too close to the British possessions, as communication might be interrupted between France and Algiers in case of war in which England was involved.

For these reasons the plans show the tunnel as starting at the Baie de Vaqueros, as an extension of the railway between Cadiz and Malaga, and running in a straight line across to Tangier; and, on emerging on the African side, the road is projected as far as Ceuta, in Morocco.

The total length of tunnel, as indicated on the plans, is 41 kilometers,—about 25½ miles, of which about 20 miles is submarine work.

M. Berlier maintains that the constructive difficulties would be no more difficult to surmount than those encountered in the Mont Cenis, St. Gothard, Arlberg, or Simplon tunnels. The principal difficulty to be anticipated is the infiltration of water, for the form of the tunnel, being that of an inverted siphon, renders the removal of water and the accomplishment of effective ventilation a rather troublesome task.

It seems doubtful whether such a project could be made commercially successful, even if the engineering difficulties could be successfully overcome. By taking into account the cost of great Alpine tunnels, M. Berlier believes the tunnel between the two continents could be made for 123,000,000 francs,—with the cost of the additional railway construction involved, a total expenditure of 225,000,000 francs; while he estimates an annual income of 6,935,000 francs from the system. It is more than probable, however, that the cost of construction would exceed the estimate, and that the receipts would fall short; and it is difficult to believe, in the present state of affairs, that such a work could prove a paying investment.

The Stability of Framework.

THE usual methods of computing the stability of framed structures involve some data which can be determined with a reasonable degree of precision, including, as they do, the weights of the various members and the maximum permissible loads which they are intended to bear. There are, however, other stresses which are not so readily calculated, involving forces which, at the best, can only be assumed, and the action of which is by no means so definitely understood. The most important of these latter stresses are those which act in a lateral direction, including

as the most important the wind pressures upon exposed surfaces.

A valuable paper upon this subject, by Herr L. Geusen, appears in the *Zeitschrift des Vereines deutscher Ingenieure*, and, although, from its mathematical nature, it cannot be fully discussed here, some of the more important conclusions may be noted, and the original commended.

The principal feature of wind stresses is the fact that they are exerted in an entirely different direction from that of the action of gravity; furthermore, they continually shift in direction, and, generally speaking, may occur from any quarter.

In order to provide for any possible contingency, Herr Geusen deduces equations for certain structures assuming the maximum force as coming successively in various directions; and, combining the resultant action upon the members with that due to the vertical forces, he discovers the combination which produces the maximum stresses in the various members of the framework. In these investigations the cases are considered in which, for any reasons of partial sheltering, only certain portions of a building are exposed to the force of the wind, and in which, therefore, very unequal and distorting combinations of strains may occur. Just such cases occur in actual practice, and usually, when a structure has failed to stand against wind pressure, it is because some unforeseen combination of forces has acted in some quite unexpected manner.

Since it is the unexpected which usually happens, it is well to be prepared, and, in order to assist in meeting the conditions which are usually neglected, Herr Geusen has collected a series of skeleton diagrams of the more commonly occurring framed structures, and gives the equations for these when considered as subject to lateral stresses upon such portions as appear to cause the maximum strains. A careful study of these diagrams, together with an examination of the theoretical and practical conditions upon which they are based, will do much to make the method of analysis clear, and the student of applied mathematics will find the paper of practical value.

A Sliding Overhead Trolley.

THE under-running roller trolley is so generally in use for electric tramway service that it is supposed to have demonstrated its superiority over sliding contact, but the use of properly-designed sliding-contact bars shows that the advantage of a roller is more apparent than real.

In the trolley system of Dresden, as described in an article by Inspector von Stobrawa in the *Elektrotechnische Zeitschrift*, the double trolley arm carries a light, slightly-bowed horizontal bar, which is pressed upward against the conducting wire in the way in which a trolley wheel is, the contact being entirely a sliding one.

As might be supposed, the first attempts to employ such a construction, using an iron bar against a copper wire, resulted in a rapid wear. A brass bar covered with white metal was substituted, and, though this much reduced the wear upon the line wire, the bar itself lasted only about two weeks. A further improvement was then made by using an aluminum channel bar with a central bar of white metal, the spaces between being filled with a lubricating grease.

Thus constructed, the bar lasts six to eight weeks, corresponding to about 8,000 car-kilometres, and the general results are satisfactory. Contrary to the first supposition, the wear upon the line wire is less than with the roller trolley, for with the latter the side wear upon the wire is very great, especially upon curves, while with the sliding contact, after a slight flat bearing has been formed upon the conductor, further wear is very slight. These results are obtained from the experience at Dresden, where copper conductors are used. At Basle, where the line conductor is of aluminum, and therefore of greater diameter, the contact area is increased and the wear diminished, so that a trolley bar lasts two or three times as long,—an additional argument in favor of the larger conductor, in this respect at least.

Practical experience with this form of trolley has been had at Berlin, Mulhausen, Hanover, Barmen, and other cities, and for the above reasons it has been found preferable to the roller.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, in the original language, and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 15c. The letter A, B, or C denotes a price of 30 cts.; D, of 45 cts.; E, of 60 cts.; F, of 75 cts.; G, of 90 cts.; and H, of $1.35. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell the coupons which are represented here in miniature.

The price of these coupons is 15c. each, or fifteen for $2, forty for $5, and one hundred for $12.

This Coupon will be received by us in payment for any 15 cent article catalogued in "The Engineering Index" of the ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be required for each 15 cents: thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on.
The Engineering Magazine, New York:
Please send Article No. _____ to the following address:
Facsimile Not Good

With a supply of these coupons on hand, no letter writing is required. Simply fill in the number and your address. A stamped envelope does the rest.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their convenience.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash , D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécan'que. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio.
Scribner's Magazine. *m.* New York
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Alliance Building.

A Proposed Building for the Scientific Alliance of New York. Report of the Building Committee. Gives history of the efforts to obtain a building for use of the Alliance, and the designs submitted for the new building. Ill. 2800 w. Science—March 25, 1898. No. 19119.

Bank.

The Buffalo Bank of Commerce. Illustrates a modern fireproof structure built for a large bank, and gives details of construction. 1500 w. Eng Rec—March 26, 1898. No. 19132.

Brickwork.

Strength of Brick Masonry. Ira O. Baker. Part first discusses the importance of not underestimating the strength and the extravagance of over estimating it, giving some results of experiments. 1800 w. Br Builder—March, 1898. Serial. 1st part. No. 19147 C.

The Economy of Brick Structures as Compared with Those of Wood. R. N. Buell. Read at the Pittsburg meeting of N. B. M. Assn. Considers the comparative cost of wood and brick structures, and other advantages, and how to demonstrate the superiority of brick to the builders of American homes. 3000 w. Brick—March, 1898. No. 18787.

Chimney.

The Stability of a Chimney. (Standfestigkeit eines Schornsteines.) J. Goebel. An analytical investigation of the resistance of chimneys of various sections and dimensions against wind stresses. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1898. No. 19244 D.

Church.

The Church of St. Martin, Wareham, Dorset. Charles Lynam. A study of the details of this church, with illustrations. 2500 w. Builder—March 12, 1898. No. 19071 A.

Concrete Construction.

Cement and Steel Buildings. Illustrates the construction of small shops and schools having concrete and expanded metal walls and partitions. 700 w. Eng Rec—March 26, 1898. No. 19133.

Steel Concrete Construction. George Hill. Deals with that combination of concrete and steel in which the steel acts entirely in tension, and in which it is distributed through the bottom section of the slab. An account of tests and results. Ill. 5500 w. Pro of Am Soc of Civ Engs—March, 1898. No. 19107 F.

Court Building.

The Appellate Court Building. Charles H. Coffin. Illustration with brief description of a beautiful building in process of construction at the corner of Madison Ave. and 25th Street, New York City. 600 w. Harper's Wk—April 2, 1898. No. 19188.

Exposition.

Exposition of 1900, Paris. (Exposition de 1900.) Giving the final plans and arrangement of buildings adopted for the Esplanade des Invalides and the Champ de Mars. 800 w. 1 plate. Le Génie Civil—March 5, 1898. No. 19217 D.

Fireproofing.

Burned Clay as a Fire-Proofing Material. W. D. Henry. Read at the Pittsburg meeting of the N. B. M. Assn. Considers the adaptability of burned clay to fire-proofing, the proper way to make it, the results, &c. 3500 w. Brick—March, 1898. No. 18786.

Expanded Metal in Its Relation to Fireproof Construction. J. F. Golding. Paper read at a meeting of the Civil and Mech. Engs.' Society, England. Some information of the manufacture of this material and the uses to which it can be applied. 1400 w. Arch, Lond—Feb. 25, 1898. Serial. 1st part. No. 18842 A.

How to Build Fire-Proof. Francis C. Moore. Considers twelve important propositions bearing on this subject, or rather on slow-burning buildings and their care. 3800 w. Br Build—March, 1898. No. 19149 C

The Hamburg Experiments on the Fireproofing of Cast Iron, Wrought Iron, and Wooden Columns. (Die Hamburger Versuche über die Feuersicherheit Gusseisener, Schmiedeisener, und Hölzener Säulen.) Tests were made of bare columns, also with sheathings of concrete, asbestos cement and similar materials; discussion is appended. 1800 w. Zeitschr d Ver Deutschr Ing—Feb. 12, 1898. No. 19245 D.

Grain Elevators.

Steel Tank Grain Elevators "Electric" and "Fort William." Illustrates and describes the two most recent structures of this class, one at Buffalo, N. Y., the other at Fort William, Ont. 1200 w. Eng News—March 17, 1898. No. 19023.

Theatre.

Revolving Stage of the Paris Variety Theatre. (Scène Tournante du Théatre des Variétés à Paris.) The inclined floor of the stage revolves like a turn-table, thus enabling one setting to be prepared while the other is being used, and making very prompt changes of scene possible. 1000 w. Le Génie Civil—March 12, 1898. No. 19221 D.

The Housing of the Drama. Edwin O. Sachs. Treats of the aspects under which a playhouse devoted to the drama can be constructed, with special reference to subscription and endowed theatres. Also discussion. Ill. 10000 w. Jour Roy Inst of Brit Archs—Feb. 12, 1898. No. 18834 B.

HEATING AND VENTILATION.

Astoria Hotel, N. Y.

Ventilation of the Astoria Hotel, New York City. A general description of the hotel and the ventilating plant, which has a capacity of 15,000,000 cu. ft. of air per hour. The air is moderately warmed and the heating of the rooms is by direct radiation. Ill. 2200 w. Eng Rec—March 19, 1898. Serial. 1st part. No. 19039.

Blower System.

Some Facts in the History of the Blower System. Walter B. Snow. Traces the progress of this system from its earliest history. Ill. 1500 w. Met Work—March 19, 1898. Serial. 1st part. No. 19027.

Church Heating.

The Heating and Ventilation of Central Presbyterian Church and Sunday School, Erie, Pa. Illustrates and describes the installation of a fan system in a building provided only for a system of direct heating. 1200 w. Heat & Ven—Feb. 15, 1898. No. 18718.

English Criticism.

An English Criticism on American Practices in Erecting Domestic Hot-Water supply Apparatus. Frederick Dye. The object of the article is to point out faults with the view of showing how the work may be improved. Ill. 1800 w. Heat & Ven—Feb. 15, 1898. No. 18719.

French Practice.

Steam Distribution in France Without Pressure in Radiators. Other French Practice. G. Debesson. Brief description of systems of steam distribution through piping into the radiators, also a combination system using both steam and hot water, and other work. Ill. 1100 w. Heat & Ven—March 15, 1898. No. 19110.

Gas-Heating Appliances.

The Efficiency and the Waste of Heat in Gas-Heating Appliances. Dr. Haber. Abstract. Gives a mode of calculation where there is no need for an analysis of the gas or for a determination of its specific gravity. 1200 w. Gas Wld—Feb. 19, 1898. No. 18734 A.

Heat Transmission.

Transmission of Heat Through Copper Coils. Discusses many experimental results and shows the need of more data. 1000 w. Eng Rec—March 5, 1898. No. 18888.

Hot-Water Heating.

English Views on Hot-Water Heating. W. J. Maguire. Brief explanation of the writer's methods and the reasons. 1600 w. San Plumb—March 1, 1898. No. 18932.

Pipe Coverings.

See Mechanical Engineering, Miscellany.

Radiating Surface.

A Chart for Determining Radiating Surface. Gives a diagram for reading off readily the radiating surface of any room with either steam or hot-water heating. 700 w. Eng Rec—March 5, 1898. No. 18896.

School.

Heating and Ventilating a Bayonne (N. J.) School. Illustrated description of a low-pressure steam heating and ventilating system. 1200 w. Met Work—March 12, 1898. No. 18918.

Steam Heating.

Systems and Apparatus for Heating Buildings by Steam. J. J. Blackmore. An exposition of the principles governing the design of an economical plant, reviewing the three distinct systems and the conditions under which they are applicable. 3500 w. Engineering Magazine—April, 1898. No. 19291 B.

PLUMBING AND GASFITTING.

Astoria Hotel.

The Astoria Hotel, New York City. Gives some features of the plumbing, drainage, and water supply, describing the Continental system of filtration. Ill. 2800 w. San Plumb—March 1, 1898. No. 18931.

Electrical Work.

Plumbing and Electrical Work. James F. Hobart. The first of a series of articles whose aim is to present the matter of simple electrical working in such a plain manner that the principles may be understood and the work executed. 2700 w. Dom Engng—March, 1898. Serial. 1st part. No. 19055 C.

House Drainage.

House Drainage from an English Standpoint. James I. Little. Describes the underground drainage, how drains should be laid, &c, in accordance with English practice. 1400 w. San Plumb—March 15, 1898. No. 19104.

Lead Pipe.

How Lead Pipe Is Made. Account of the manufacture. 1700 w. San Plumb—March 15, 1898. No. 19103.

Lead Work.

Lead Work, Plain and Decorative. F. W. Troup. Describes the uses made of lead by early architects, as roofs, crockets, figures, &c. Discussion. 8500 w. Builder—March 5, 1898. No. 18960 A.

Water Pipes.

Computation of Water-Heating and Water-Conducting Systems in an Elementary Manner. (Berechnung von Wasserheizungs- und Wasserleitungs-Anlagen auf Elementarem Wege.) Rudolf Mewes. A very full and elaborate discussion of the practical computation of the dimensions of water pipe systems to obtain a desired capacity of flow. Two articles. 10000 w. Gesundheits-Ingenieur — Jan. 31, Feb. 15, 1898. No. 19284 each B.

MISCELLANY.

Architectural Study.

On the Study of Architecture. George Aitchison. An address delivered before the Birmingham Arch. Assn. Some suggestions as to the proper course to be pursued by students, and the aims of true architects. 2300 w. Brit Arch—March 11, 1898. No. 19069 A.

Artificial Marble.

Artificial Marble in Sicily. Information concerning the manufacture of artificial black marble. 800 w. Cons Repts—March 26, 1898. No. 19144 D.

Bradford, Eng.

The Architecture of our Large Provincial Towns. Illustrated description of the architecture of Bradford, England. 5800 w. Builder—Feb. 19, 1898. No. 18732 A.

Campanili.

The Mediæval Campanili of Rome. J. Tavenor Perry. Illustrated description and historical account of these bell-towers. Also discussion. Ill. 8000 w. Jour Roy Inst of Brit Archs—Feb. 26, 1898. No. 19150 B.

Columbia University.

Columbia University, N. Y. Illustrated description of the new buildings, especially the library, with brief history of the college. 3000 w. Sci Am—March 26, 1898. No. 19090.

Efflorescence.

On the Saline Efflorescence of Bricks. Oscar Gerlach. Considers the causes leading to it, and the practical means of avoiding the same. 2300 w. Br Build—March, 1898. Serial. 1st part. No. 19148 C.

Egypt.

Egypt, the Birthplace of Architecture. G. A. T. Middleton. Read before the Society of Architects, England. Historical description of the architecture of this country. 3500 w. Arch, Lond—March 4, 1898. No. 18957 A.

Expositions.

The Tennessee Centennial Exposition. Brief discussion of the plan with criticisms. 2400 w. Arch Rev—Vol. V. No. II., 1898. No. 19112 F.

The Trans-Mississippi Exposition. C. Howard Walker. Illustrated description of the architecture, with general discussion of the requirements of buildings for expositions. 4000 w. Arch Rev—Vol. V. No. II. 1898. No. 19111 F.

Fees.

The Law of Architects' Fees in Scotland. Gives the decision of a case in Edinburgh, by Lord Kincairney. 1200 w. Arch, Lond—March 18, 1898. No. 19155 A.

Kensington.

Kensington Palace. From the London *Times*. An account of this noted palace, the birthplace of Queen Victoria, and description of some parts of it. It is to be put in order and opened to the public. 2000 w. Arch, Lond—Feb. 18, 1898. No. 18736 A.

Monuments.

The Conservation of Historical Monuments in Italy. Alfredo Melani. Reviews the provisions made for this purpose, and the mistakes which resulted in the loss of many monuments. 2700 w. Am Arch—Feb. 26, 1898. No. 18753.

Mosaics.

An Improved Process and Apparatus for Manufacturing Mosaics. Report of the Institute, through its Committee on Science and the Arts, on the invention of Herman C. Mueller, of Zanesville, Ohio. Description of the invention, with commendation. 2700 w. Jour Fr Inst—March, 1898. No. 18810 D.

Pompeii.

Pompeii—A City of the First Century. Prof. Adams. Abstract of a lecture delivered before the resident members of the Province of Quebec Assn. of Architects at Montreal. An interesting historical and descriptive account of this ancient city. 6200 w. Can Arch—March, 1898. Serial. 1st part. No. 19058 C.

Pyramids.

Scientist Explodes the Mystery of the Pyramids. J. D. M'Guire in the *Indianapolis News*. Abstract. The story of their erection, processes of construction, &c. 2000 w. Stone—March, 1898. No. 19106 C.

Renaissance.

The Florentine Renaissance. George Aitchison. The fourth Royal Acad. lecture on architecture this session. Considers the works and influence of the celebrated architects of this period. 2500 w. Builder—Feb. 26, 1898. No. 18866 A.

The Florentine Renaissance. George Aitchison. The fifth Royal Academy lecture on architecture this session. Describes some of the most remarkable buildings of the architects of this period. 3500 w. Builder—March 5, 1898. No. 18959 A.

The Middle and Later Renaissance. George Aitchison. The sixth and last Royal Academy lecture on architecture this session. The influence of Vitruvius' work, and a review of the fine buildings of this period. 3800 w. Builder—March 12, 1898. No. 19072 A.

Scottish Churches.

Scottish Church Architecture of the Fourteenth and Fifteenth Centuries. Hippolyte J. Blanc. Read at meeting of the Architectural Assn., London. Sketches some of the most prominent examples and makes comparison with contemporaneous work in England. 4500 w. Arch, Lond—March 18, 1898. No. 19154 A.

Store Fronts.

The Painting and Decorating of Store Fronts. Walter J. Pearce. Suggestions for the use of characteristic details in the ornament of shops. The illustrations given are such as could be used on pilasters. 2400 w. Plumb & Dec—March 1, 1898. No. 18962 A.

Terra-Cotta.

Architectural Terra-Cotta. Thomas Cusack. Considers the importance of coöperation between architect, engineer and clay worker, illustrating by example the defective work resulting from the lack of coöperation. Ill. 2000 w. Br Build—March, 1898. No. 19146 C.

Unfinished Work.

Thoughts Suggested by the New Porches of Trinity Church, Boston. H. R. M. Questioning the wisdom of attempting to complete this unfinished work of Richardson. Ill. 2200 w. Scribner's Mag—April, 1898. No. 19117 C.

University.

The Surroundings and New Buildings of the University of Leipzig. (Die Um- und Neubauten der Universität Leipzig.) With plans of the old arrangement when the cloister was standing, also the condition before the new work, as well as the present improved arrangement. 1800 w. Deutsche Bauzeitung—Jan. 22, 1898. No. 19287 B.

CIVIL ENGINEERING.

BRIDGES.

Arch.

Beton Bridge with Imbedded Iron Ribs. (Betonbrücke mit Eisenrippen-Einlagen.) A very light and effective Melan Arch of 72 feet span forming a roadway over the Klampenborg-Helsingör railway near Skodsborg, Denmark. 800 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 25, 1898. No. 19259 B.

Boat Bridge.

Boat Bridge Over the Indus at Khushalgarh. Brief account with illustration. 400 w. Ind Engng—Feb. 19, 1898. No. 19151 D.

Bridge Removal.

Renewing a Bridge. Describes an interesting engineering feat performed by the Chicago & Northwestern Railway, in the removal of the old drawbridge near Kinzie street, Chicago, and the substitution of a new span. Ill. 700 w. Ry Age—March 18, 1898. No. 19054.

Bridge Shops.

Notes from American Bridge Shops. Part first presents information of the Elmira Bridge Co., of Elmira, N. Y., and the Union Bridge Co., of Athens, Pa. Ill. 2200 w. Eng News—March 3, 1898. No. 18774.

Cantilever.

Partially Connected Cantilever Bridge over the Chéliff. (Pont à Jonction Centrale Partielle sur le Chéliff, Algérie.) Describing a peculiar form of cantilever in which a partially rigid connection is made in the middle of the central span. 2000 w. Le Génie Civil—Feb. 26, 1898. No. 19215 D.

Foundations.

Submerged Concrete Laying. Slightly condensed from the report of William Jackson. Describes methods used on a bridge at Boston, Mass. 1500 w. Eng Rec—March 5, 1898. No. 18890.

Depositing Concrete under Water at Charlestown Bridge, Boston, Mass. Describes some difficult work in making the foundations for two of the piers of this bridge. Ill. 1400 w. Eng News—March 17, 1898. No. 19026.

Highway Bridge.

A Highway Bridge with Concrete and Brick Floor. L. B. Merriam. A bridge lately erected in DeKalb, Ill., of interest because of the unusually heavy dead load caused by the use of concrete and brick for driveway floor, and concrete sidewalks. 1200 w. Eng News—March 10, 1898. No. 18912.

The Construction of a Road Bridge over the Doubs at Verdun. (La Construction d'un Pont Route sur le Doubs à Verdun.) Detailed description of this handsome stone arch bridge, of three spans, 135 feet each. Diagrams of the masonry and the centerings are given, and photographs of the completed structure. 3000 w. 2 plates. Ann des Ponts et Chaussées—4 Trimestre, 1897. No. 19236 F+G.

Queensland.

Burdekin River Bridge—Queensland Government Railways. H. C. Stanley. Illustrates and describes a high-level bridge in Australia. 900 w. Ry & Engng Rev—March 19, 1898. No. 19078.

Replacement.

Replacement of the Old Metal-Span of the Pennsylvania Railroad Bridge Over the Schuylkill River at Philadelphia, October 17, 1897. Joseph T. Richards. Description showing the preparations and conditions under which a transfer was made in 2 minutes and 28 seconds. Ill. 3000 w. Pro Engs' Club of Phila—Jan., 1898. No. 18767 D.

Steel Bridge.

Mill Street Bridge, Watertown, N. Y. Illustrates and describes a short-arch bridge of unique design erected by an unusual form of false work. 1300 w. Eng Rec—March 5, 1898. No. 18889.

Swing-Bridge.

Chicago, Madison, and Northern Railroad Company's Bridge. Details of superstructure of a double-track 474-ft. swing-bridge, with illustrations. 1000 w. Eng Rec—March 19, 1898. No. 19035.

Viaduct.

Designs for the Massachusetts Avenue Viaduct at Washington, D. C. Two designs for crossing Rock Creek, one a stone arch, and the other a steel arch. Ill. 600 w. Eng News—March 10, 1898. No. 18908.

Wooden Bridges.

The Life of Wooden Piles and Bridges. William Gammons. Abstract of an address before the bridge and building department of the C. M. & St. P. Ry. 1000 w. Eng Rec—March 12, 1898. No. 18926.

CANALS, RIVERS AND HARBORS.

American Harbors.

Great Harbors on Our Seaboard. Cyrus C. Adams. Describes some of the harbors of the United States, and their commercial importance. 2500 w. Chau—April, 1898. No. 19186 C.

Antwerp Port.

The Extension of the Port of Antwerp. Part first gives a statement of the conditions and discusses some of the plans submitted for the extension of the port. 2200 w. Engr, Lond—March 11, 1898. Serial. 1st part. No. 19062 A.

Bear Trap Dam.

Bear Trap Dam for Regulating Works, Chicago Drainage Canal. Detailed illustrations and full description of this dam, the largest structure of its type in the world. 5500 w. Eng News—March 24, 1898. Serial. 1st part. No. 19084.

Breslau.

The Opening of the New Ship Channel at

Breslau. (Zu der Eröffnung des Grosschiffahrtsweges in Breslau.) Brief description with photographs of the docks, bridges and locks. 800 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 18, 1898. No. 19255 B.

Dismal Swamp.

Reconstruction of the Dismal Swamp Canal. Description and profile showing the condition of the canal when the improvements were started, with account of the work now in progress. Ill. 2300 w. Sci Am—March 5, 1897. No. 18764.

Docks.

A Modern Coal Dock. Edward N. Saunders, Jr. Describes the dock of the Northwestern Coal Railway Co., at Superior, Wis. Ill. 1800 w. Yale Sci M—March, 1898. No. 19016 C.

Drainage Canal.

Drainage Canal. Isham Randolph. Statistics relating to the growth of Chicago are given, with illustrated account of work on the sanitary canal. 8000 w. Jour of W Soc of Engs—Dec., 1897. No. 18804 D.

Dredges.

See Electrical Engineering, Power.

Dredging.

European Sea-Going Dredges and Deep-Water Dredging. E. L. Corthell. Reviewing the importance of harbor and channel improvement and the increasing use of powerful dredges for this service, with many illustrations of typical sea-going dredges of European construction, and data of capacity and cost of operation. 4500 w. Engineering Magazine—April, 1898. No. 19290 B.

Dry Docks.

Our Naval Dry Docks. An editorial statement placing the blame of naval dry-dock failures on line officers' interference with civil engineers. 1200 w. Eng Rec—March 5, 1898. No. 18886.

The Construction of the Lorain Dry Dock and Shipyard of the Cleveland Ship-Building Company. James Ritchie. Illustrated detailed description of this work. 5000 w. Pro of Am Soc of Civ Engs—March, 1898. No. 19108 F.

Erie Canal.

The Future of the Erie Canal. Thomas W. Symons. Advocates federal control. 3000 w. Eng Rec—March 19, 1898. No. 19036.

Flow.

A Study of a New Formula for calculating the Discharge of Open Channels. (Etude d'une Nouvelle Formule pour Calculer le Débit des Canaux Découverts.) H. Bazin. A most important contribution to hydraulic engineering by high authority; developing a much simpler formula than has hitherto been used. The formula is intended to replace the more complicated one of Ganguillet and Kutter. 12000 w. 1 plate. Ann des Ponts et Chaussées—4 Trimestre, 1897. No. 19232 F+G.

The New Formula of Bazin. (La Nouvelle Formule de M. Bazin.) An abstract of the experiments of Bazin and his derivation of a new formula for determining the flow of water in open channels. 1200 w. Le Génie Civil—March 5, 1898. No 19219 D.

Fulda.

The Canal Works on the Fulda Between Cassel and Münden. (Die Canalisierung der Fulda zwischen Cassel und Münden.) A. Herbst. With profile, and plans and sections of canal locks. 3500 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—March, 1898. No. 19282 D.

Harbor Improvement.

Development of the Port of Plymouth, Eng. An explanation of the two projects before the local authorities for the improvement and extension of the port and harbor. 1600 w. Engr, Lond—Feb. 18, 1898. No. 18724 A.

Improve New York Harbor. Suggestions for needed improvements from a pamphlet published by John W. Ambrose. 1000 w. Fire & Water—March 5, 1898. No. 18821.

The Improvement of Plymouth Harbor. Plan showing the position of the proposed works and describing the arrangements. 1300 w. Engr, Lond—Feb. 25, 1898. No. 18858 A.

Lighthouses.

The Optical Apparatus of Lighthouses. (Appareils Optiques des Phares.) M. Ribière. A graphical and mathematical treatment of the figures for the lenses of lighthouse apparatus, with experimental verification of the theoretical deductions 10000 w. 3 plates. Ann des Ponts et Chaussées—4 Trimestre, 1897. No. 19234 F+G.

Electric Lighting and the Eckmuhl Lighthouse. (L'Eclairage Electrique et le Phare d'Eckmuhl.) M. de Joly. A general description of the extensive introduction of electric lighting in the lighthouses on the coast of France, together with an account of the inauguration of the new Eckmuhl lighthouse. 12000 w. 2 plates. —Ann des Ponts et Chaussées—4 Trimestre, 1897. No. 19233 F+G.

New York's Canals.

Federal Ownership of New York's Canals. Hearing before the Senate judiciary committee on Wednesday, March 9, on the Pavey resolution providing for the amendment of the constitution so as to make possible the transfer of New York's canals to the Federal Government. 2800 w. Sea—March 17, 1898. No. 18995.

Sea Walls.

Sea Walls on the North Sea Coast. (Strandmauern an der Nordseeküste.) With illustrations showing the different kinds of sea walls and methods of construction on the coasts of Denmark, Holland, Belgium, and Germany. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 25, 1898. No. 19257 B.

Sfax.

The Port of Sfax, Tunis. (Port de Sfax.) M. Bezault. Describing the dredging of the channel and the construction of the docks and quays of this port of Tunis, under the direction of the French protectorate. 4500 w. 1 plate. Ann des Ponts et Chaussées—4 Trimestre, 1897. No. 19235 F+G.

Ship Canal.

Proposed Canal from American Lakes to Atlantic. Discusses the project and Major Symons' report. 1100 w. Engng—March 11, 1898. No. 19061 A.

Towing.

See Electrical Engineering, Power.

IRRIGATION.

Central India.

Tank Irrigation in Central India. George Palmer. Describing the reservoir system of irrigation used in the State of Hyderabad, with an account of the topographic, climatic, and administrative influences affecting the system; with maps and tables. 3000 w. Engineering Magazine—April, 1898. No. 19293 B.

Dam.

The Hemet Dam, California. A plan profile and cross section of this arched-masonry dam, with a few facts regarding it. 800 w. Eng News—March 24, 1898. No. 19087.

The Repair and Extension of the Sweetwater Dam. H. N. Savage. An illustrated description of the construction of this curved masonry dam, and its repair and raising after being overtopped by a heavy flood. 3000 w. Eng Rec—March 12, 1898. No. 18927.

See also Municipal Engineering, Water Supply.

Pump Irrigation.

Pump Irrigation in the West. Hunter Morrison. Describes method of irrigating the Great Plains of Kansas, Nebraska, &c., and the benefit derived. Ill. 1500 w. Yale Sci M—Feb., 1898. No. 18691 C.

MISCELLANY.

Brickwork.

See Architecture and Building, Construction.

Cableways.

Cableway Transportation and its Applications to Agriculture, Industry and Construction. (Transports par Cables Aeriens et leurs Applications à l'Agriculture, à l'Industrie, et aux Constructions.) A paper before the society of civil engineers of France by M. Thiéry showing the economical advantages of cableways, with reference to successful installations in France and in the United States. 2000 w. Moniteur Industriel—March 12, 1898. No. 19242 G.

Cement.

Progress in the Manufacture of American Portland Cement. John W. Dickinson. Brief history of this industry in the United States, with remarks on quality and cost. 1700 w. Munic Engng—March, 1898. No. 18745 C.

Testing Cement. A discussion introduced by Thomas T. Johnston. 2500 w. Jour of W Soc of Engs—Dec., 1897. No. 18806 D.

Concrete Construction.

See Architecture and Building, Construction.

Decimal System.

The Extension of the Decimal System to the Day and to the Circle. (Sur l'Extension du Système Décimal au Jour et au Cercle.) M. Rey-Pailhade. Presenting the arguments in favor of the practical advantages of the change from the sexagesimal to the decimal division of the circle and the day. 1200 w. Comptes Rendus—Feb. 14, 1898. No. 19224 D.

Explosives.

The High Explosives Used in Naval Warfare. Remarks on the different forms of these explosives and their power and safety. 1300 w. Eng News—March 24, 1898. No. 19088.

Highways.

State Highways in Massachusetts. Editorial giving a statement of methods of selecting state roads and pointing out defects in present laws. 1500 w. Eng Rec—March 26, 1898. No. 19130.

The Influence of Tire Width on Draft of Wagons. Describes experiments at the Missouri Agricultural College showing wide tires to draw easier on all roads, except under conditions arising but rarely. 1800 w. Eng Rec—March 12, 1898. No. 18928.

Malay States.

Engineering in the Malay States. Information regarding the present conditions and future prospects of engineering in this new field. 1800 w. Engng—March 4, 1898. No. 18951 A.

Stability.

Methods of Applying the Trapezoidal Formula to Computations of Stability. (Diverses Manières d'Appliquer la Règle du Trapéze au Calcul de la Stabilité.) Maurice Lévy. Particularly devoted to the application of the method to the determination of the stability of masonry dams, especially against sliding. 2500 w. Ann des Ponts et Chaussées—4 Trimestre, 1897. No. 19231 F+G.

Stadia-Rods.

The Conditions of Accuracy of Stadia Rods. (Die Bedingungen der Schätzungsgenauigkeit an Massstäben.) Anton Tichy. A very full investigation of the methods of calibrating graduated rods for use in stadia surveying and the computation of the probable error. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—March 4, 11, 1898. No. 19260, each B.

Surveyors.

County Surveyors and Surveyors-General. J. L. Van Ornum. Reviews the laws of the differing states governing the election of these officers, and shows that changed conditions have made necessary a revision of past practice. Points out the duties required and qualifications needed. 3000 w. Eng News—March 3, 1898. No. 18769.

Tunnel.

Proposed Tunnel under the Strait of Gibraltar. (Projet de Tunnel sous le Détroit de Gibraltar.) With maps, and general outline of the scheme of M. Berlier for the construction of a tunnel under the strait of Gibraltar, between Tarifa in Spain, and Tangier, Morocco. 1200 w. Le Génie Civil—Feb. 19, 1898. No. 19214 D.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Exports.

American Clover Seed in Austria-Hungary. Reports an attempt to exclude this product, claiming that it is infected with kleseide (commonly known as dodder), but the real reason is that competition is having a demoralizing effect on the market. 800 w. Cons Repts—March 28, 1898. No. 19159 D.

Foreign Trade. John A. Johnson. Discussing the possibilities for the manufactured products of the United States. 1600 w. Mach, N. Y. —March, 1898. No. 18874.

Brazil.

New Brazilian Customs Tariff. Statement giving a translation of the section dealing with cotton yarns and manufactures. 2000 w. Bd of Trd Jour—Feb., 1898. Serial. 1st part. No. 18704 A.

Brazil Exports.

Warning to Exporters of British Goods to Brazil. Calling attention to the injury to trade due to piracy of trade marks, owing to the inferiority of the products passed under name of good manufacturers, and the steps taken by the government to control and regulate this kind of trade. 1200 w. Bd of Trd Jour—March, 1898. No. 19301 A.

British East Africa.

Trade and Shipping of the British East Africa Protectorate. Report on the condition and progress since its establishment to the 20th of July, 1897. 1000 w. Bd of Trd Jour—Feb., 1898. No. 18703 A.

British India.

Openings for Capital in British India. Abstract of an article published in a Calcutta weekly on the concentration of industries in British India and the openings for capital which present themselves in that country. 1300 w. Bd of Trd Jour—March, 1898. No. 19303 A.

British Trade.

Foreign Trade of the United Kingdom. Report of the imports and exports for the month, and two months, ending Feb. 28, 1898, with comparison of the previous year. 900 w. Bd of Trd Jour—March, 1898. No. 19300 A.

Canal Traffic.

The Traffic on the "Kaiser Wilhelm" Canal. Report of the British Consul-general at Hamburg on the traffic of this canal during the year 1896-1897. Shows an increase of traffic; also gives other particulars of interest. 1000 w. Bd of Trd Jour—Feb., 1898. No. 18700 A.

China.

British Commercial Relations with China and the Establishment of the Inspectorate General of Chinese Imperial Maritime Customs. A summary of the leading changes in the international commercial relations between Great Britain and China during the present century. 3000 w. Bd of Trd Jour—Feb., 1898. No. 18699 A.

Exports.

French and German Commerce. From the *Leipziger Tageblatt*. Considers the decline of the French export trade, and how it may be arrested. 500 w. Cons Repts—March 26, 1898. No. 19143 D.

Free Trade.

Mr. Gladstone on Free Trade. Gives a statement from an address before the Hawarden Horticultural Society, and discusses the situation at present in England and other countries. 2500 w. Gunton's Mag—March, 1898. No. 18882 C.

French Soudan.

The Trade and Industry of the French Soudan. Information regarding the articles of import, price, etc.; also brief notice of the resources of the country. 1500 w. Bd of Trd Jour—Feb., 1898. No. 18701 A.

Hongkong.

Economic Conditions in Hongkong. A brief review of the industrial and commercial situation of the colony during the past year. 1500 w. Cons Repts—March 12, 1898. No. 18923 D.

Italy.

Imports into Italy. A statement concerning the articles which might be exported from the United States to Italy in competition with other countries. 500 w. Cons Repts—March 7, 1898. No. 18833 D.

National Supremacy.

The Shifting Site of National Industrial Supremacy. J. Stephen Jeans. A review of the causes which have led to the transfer of international contests for supremacy from the military to the industrial field, analysing the conditions which determine supremacy in the struggle. 3500 w. Engineering Magazine—April, 1898. No. 19289 B.

Persian Trade.

The Development of Persian Trade. Considers the trade routes connecting Persia with the outer world, and the division of trade between Russia and Great Britain. Map. 2000 w. Bd of Trd Jour—March, 1898. No. 19302 A.

Prices.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Showing fluctuations in quotations from April 1, 1895, to March 1, 1898. 2800 w. Bradstreet's—March 12, 1898. No. 18944.

Resources and Trade.

South and Central American Republics—Their Resources and Trade. Part first reports the conditions found in Mexico by the commission appointed by the British Government to ascertain the prospects of British trade. Map. 9000 w. Ir & Coal Trds Rev—Feb. 18, 1898. Serial. 1st part. No. 18727 A.

Rubber Prices.

The Higher Prices for Rubber Goods Ex-

plained. Circular prepared by order of the Mechanical Rubber Mfrs. Assn., giving in detail the prices of rubber and showing the advance since 1896. 2700 w. Ind Rub Wld—March 10, 1898. No. 19050 D.

Shipment.

The Shipping and Transportation of Goods. George Eastlake. The proper method of billing goods for shipment; the classification so as to take advantage of the most favorable tariffs; and the routing of shipments to distant points. 1800 w. Ry Mag—Jan., 1898. No. 18760.

Siam.

Trade Opportunities in Siam. Information concerning this country of southeastern Asia, and the opportunities for American exporters and manufacturers. 2000 w. Cons Repts—March 15, 1898. No. 18978 D.

Tariff.

New Brazilian Tariff. A portion of the new tariff, showing the changes made from the tariff of 1896 in the principal products exported from the United States to Brazil. 3400 w. Cons Repts—March 18, 1898. No. 19017 D.

Tariff Changes and Customs Regulations. France, Spain, Italy, United States, Salvador, Venezuela, Brazil, Chile, Peru, British India, Canada, British East Africa Protectorate, Cape Colony, and Queensland. 3000 w. Bd of Trd Jour—Feb., 1898. No. 18705 A.

Tariff Changes and Customs Regulations. Russia, Belgium, Germany, France, Spain, Italy, Switzerland, Roumania, Servia, Bulgaria, United States, Brazil, Uruguay, Chile, Peru, Ethiopia, British India, St. Vincent, Lagos and Tasmania. 8500 w. Bd of Trd Jour—March, 1898. No. 19305 A.

Tariff Information to be Given by German Customs Authorities. A decree relating to the regulations to come into force April 1st, regarding information as to duties leviable on goods to be imported. 1500 w. Bd of Trd Jour—March, 1898. No. 19304 A.

"Works of Art" in the Tariff. Reports the decision of Judge Townsend, of the U. S. Circuit Court, New Haven, Conn., reversing the decision of the Board of General Appraisers in regard to the church altar, including a tomb and reredos imported into the port of New York, for an Episcopal Church at Binghamton, N. Y. 1000 w. Am Arch—March 19, 1898. No. 19051.

Yangtze-Kiang.

The Trade of Shipping of the Yangtze-Kiang. Reports the value of the import and export trade of this important commercial highway of the Chinese Empire; the use of transit passes, the shipping trade, and tabulated statements of value. 2300 w. Bd of Trd Jour—Feb., 1898. No. 18702 A.

CURRENCY AND FINANCE.

Brazil.

The Brazilian Financial Outlook. An account of the financial difficulties of the last year, and their causes. 1000 w. Bankers' Mag, Lond—March, 1898. No. 18946 A.

Currency Reform.

Suggestions for Currrency Reform. J. A. Ayers. A proposition to replace the legal-tender and treasury notes with national bank notes. Relating to the United States. 500 w. Bankers' Mag, N. Y.—March, 1898. No. 18982 D.

Federal Finance.

Seven Years of Federal Finance. Frederick C. Clark. A retrospective study, showing the operation of economic laws, and the disastrous effect of politics, reviewing some of the important events in the United States. 4800 w. Bankers' Mag, N. Y.—March, 1898. No. 18980 D.

Great Britain.

The Financial Relations of England, Scotland, and Ireland. Discusses the contention of Ireland that it was paying more and receiving less than England or Scotland. 2500 w. Bankers' Mag, Lond—March, 1898. No. 18947 A.

International Finance.

The Immorality and Cowardice of Modern Loan-Mongering. A. J. Wilson. Considering a few of the features of "high finance," and discussing some of the probable consequences on the development of modern civilization. 4000 w. Contemporary Rev—March, 1898. No. 19002 D.

Monetary Reform.

Proposed Reform of the Monetary System. J. F. Johnson. A critical examination of two plans recently laid before the United States Congress and known respectively as the Gage plan and the Monetary Commission plan. 12500 w. An Am Acad—March, 1898. No. 18836 H.

Monetary Securities.

Origin and Growth of the Law Governing the Transfer of Monetary Securities. The story of monetary securities and the law governing their transfer; also considers the origin of Great Britain's public debt, rise of the speculative mania, the British consuls, and other related matters. 10000 w. Bankers' Mag, N. Y.—March, 1898. No. 18981 D.

Russia.

Russian Currency Reform. From the official report to the Emperor. Gives an account of the state of the currency, illustrating the present economic condition of the empire, and calls attention to points of importance for the preservation of the currency from future fluctuations. 4500 w. Bankers' Mag, N. Y.—March, 1898. No. 18979 D.

GOVERNMENTAL CONTROL.

Contractors' Rights.

Concerning the Rights of Contractors and Authority of Architects. Decision of the case of Lynch & Woodward against Josiah Quincy *et al.*, as given by Judge Richardson. Of interest to architects, contractors and mechanics. The right to employ non-union laborers. 1700 w. Br Build—Feb., 1898. No. 18711 C.

Legislation.

Political and Municipal Legislation in 1897. E. D. Durand. A study of some of the most noteworthy statutes passed in the United States during the year. 5700 w. An Am Acad—March, 1898. No. 18835 H.

LABOR.

British Trade Unions.

What They Propose to Do. Gives proposed demands and propositions. 1000 w. Engng Mech—March, 1898. No. 19145 C.

Compensation.

Workmen's Compensation in the Coal Industry. A memorandum issued to the ordinary members of the Lancashire and Cheshire Miners' Permanent Relief Society on the comparative advantages and disadvantages of the Workmen's Compensation Act. 1700 w. Ir & Coal Trds Rev—March 11, 1898. No. 19067 A.

Workmen's Compensation in the Coal Trade of Germany. Statistics from the records of the *Knappschafts* Trades' Assn. with remarks. 1800 w. Ir & Coal Trds Rev—March 18, 1898. No. 19183 A.

European Laborers.

Labor Conditions in Europe. A comparison showing the actual condition of things relating to the cost of living among the laboring classes of Europe. 2200 w. Cons Repts—March 21, 1898. No. 19068 D.

Inventions.

See Mechanical Engineering, Miscellany.

Japan.

Industrial Japan. Editorial on the industrial development, and the views of Mr. Brenan and Count Okuma. 2000 w. Engng—Feb. 25, 1898. No. 18869 A.

Labor Troubles in Japan. Discussing the hard conditions necessarily accompanying the transition from ancient to modern methods. 2400 w. Gunton's Mag—March, 1898. No. 18883 C.

Mining Labor.

Capital and Labor in Coal Mining During the Last 200 Years. J. B. Simpson. Extracts from a paper read before the Newcastle (Eng) Economic Society. Reviews the changes and present conditions concluding that the selling price will continue to be the guiding factor for wages. 2800 w. Col Guard—March 18, 1898. No. 19176 A.

Strike.

The Late Strike in England. W. H. Booth. Reviewing this labor trouble, its causes and lessons. 3500 w. Am Mach—March 17, 1898. No. 19020.

Unemployed.

The Tramp and the Labor Colony in Germany. A. F. Weber. Reviews methods of treatment of this class in various places, giving special account of methods in Germany, the shelters and labor colonies, and suggested methods of reform. 3500 w. Chau—March, 1898. No. 18693 C.

Union Label.

The Trade-Union Label. John Graham Brooks. Account of the trade-union label, which seems to be of American origin, the causes for its adoption, and what it stands for. 12000 w. Bul of Dept of Labor. March, 1898. No. 19029 D.

MISCELLANY.

Acetic Acid.

The Manufacture of Acetic Acid. (La Fabrication de l'Acide Acetique.) Fr. Miron. Describing the technological details of the process of obtaining acetic acid, methylic alcohol, acetone, creosote, and gaiacol by the distillation of wood. Serial. Part I. 3500 w. La Revue Technique — March 10, 1898. No. 19210 D.

American Fruits.

Germany's Exclusion of American Fruits. John B. Smith. Considers the orders issued by Germany, forbidding the introduction of fruits or living plants without having been previously inspected, and shows that the steps taken by the U. S. government uphold the fact that danger of infection from San José scale must be guarded against. 2200 w. N Am Rev—April, 1898. No. 19360 D.

Hard Rubber.

Development of the Hard Rubber Industry. Gives the history of the hard rubber industry in the United States, with interesting notes relating to accidents which led to important inventions. 3600 w. Ind Rub Wld—April 1, 1898. No. 19306 D.

Mexico.

Finances and Industries of Mexico. Statements of the estimates for the fiscal year 1898-99, presented in Dec. last to the Mexican House of Deputies. 1800 w. Cons Repts—March 3, 1898. No. 18795 D.

Patents.

The Protection of Industrial Property. J. F. Iselin. Considers, from an international point of view, the protection of patents, trade marks, designs, and other rights of the same kind. Gives history of protection of these rights in England. Also discussion. 5400 w. Jour Soc of Arts—Feb. 18, 1898. No. 18720 A.

Rubber Manufacture.

Rubber Manufacture by South American Natives. Information of practices among the natives, seeming to have originated among themselves, but which involve principles of importance in the development of rubber. Ill. 2000 w. Ind Rub Wld—March 10, 1898. No. 19049 D.

Trusts.

A New Voice on Trusts. Extracts from an address of Mr. Alfred Dolge at the annual reunion held at Dolgeville, N. Y., showing the benefits that arise to all mankind, from combination. 3000 w. Gunton's Mag—March, 1898. No. 18881 C.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Bleaching.

Bleaching by Electricity. (Die Elektrische Bleiche.) H. Wartner. Discussing the bleaching of cotton goods by means of chlorine solutions produced by electrical decomposition, with data of the commercial results obtained in Germany and in Russia. 1200 w. Elektrochemische Zeitschr—March, 1898. No. 19274 D.

Electro-Chemical Products.

The Manufacture of Electro-Chemical Products. An account of the methods adopted in the works of the Electro-Chemical Co., of St. Helens, where caustic soda, bleaching powder and chlorate of potash are manufactured. Ill. 2000 w. Elec Rev, Lond—March 11, 1898. No. 19075 A.

Electro-Deposition.

On Some Recent Investigations in Connection with the Electro-Deposition of Metals. J. C. Graham. Communicated to the Royal Society. Experiments appearing to give some light regarding the conditions necessary for the rapid deposition of metals from their solutions by mean of the electric current. 1000 w. Elec Rev, Lond—Feb. 25, 1898. Serial. 1st part. No. 18846 A.

Electrolysis.

Studies in the Electrolytic Decomposition of Aqueous Solutions. (Studien über die Elektrolytische Zersetzung Wässriger Lösungen.) L. Glaser. The beginning of an elaborate discussion, starting with the theory of the H. O. chain, and proceeding to the decomposition of water and of solutions. Serial. Part 1. 2500 w. Zeitschr f Elektrochemie—Feb. 5, 1898. No. 19276, each H.

The Electrolytic Separation of Gold. (Ueber Goldscheidung auf Elektrolytischem Wege.) Dr. E. Wohlwill. A general discussion of the chemical reactions in connection with the electrolytic separation of gold from solutions of chloride or of cyanide. Serial. Part 1. 4000 w. Zeitschr f Elektrochemie—Feb. 20, 1898. No. 19277, each H.

Hulin Process.

The Hulin Electrolytic Alkali Process. John B. C. Kershaw. An account of the experiments and development of this process, with statement of its advantage. 1500 w. Elect'n, Lond—March 4, 1898. No, 18965 A.

Reflectors.

An Electrolytic Process for the Manufacture of Parabolic Reflectors. Sherard Cowper-Coles. Read before the British Institution of Elec. Engs. Describes the process, one of the chief features being that the surface produced requires no after polishing. Ill. 2500 w. Elec Eng, Lond—Feb. 18, 1898. No. 18726 A.

LIGHTING.

British Columbia.

Municipal Electric Light Plant at New Westminster, B. C. Brief account of the works and the returns. 1200 w. Can Elec News—March, 1898. No. 18873.

Central Stations.

Central Station Accessories. Part first is introductory, defining the scope of the articles to follow. They will deal with feed-water appliances, boiler appliances, feed-water heating and purifying, draining, condensing, lifting, &c. 1700 w. Elec, Lond—March 4, 1898. Serial. 1st part. No. 18971 A.

Delta, Pa.

Delta Light and Power Plant. Illustrated description of the water-power electrical generating plant of Delta, York Co., Pa. 1500 w. Am Elect'n—March, 1898. No. 18830.

Enclosed Arcs.

A Novel High-Tension Series Enclosed Arc System. J. H. Hallberg. Considers the requirements of the enclosed arc lamp for high-tension series, street lighting and commercial circuits, and calling attention to their advantages. 2200 w. Elec Rev, N. Y.—March 23, 1898. No. 19079.

Filaments.

Incandescent Lamp Filaments. Jno. C. Shedd. Reviews the early difficulties met with in this field and the solving of the problem. 1500 w. Am Elect'n—March, 1898. No. 18832.

Headlights.

See Railway Affairs, Equipment.

Higher Pressure.

Electricity Supply at Higher Pressure. Deals with the difficulties which have arisen from increasing the maximum voltage at which current is delivered, considered mainly from the consumer's point of view. 2500 w. Arch, Lond—March 11, 1898. No. 19073 A.

Hospital Lighting.

The Electric-Lighting Plant of the Boston City Hospital. H. W. Weller. Illustrated detailed description. 2200 w. Elec Eng, N. Y.—March 31, 1898. No. 19196.

Illumination.

Dr. Bunte on Incandescent Lighting, Acetylene, and the Development of Flame Illumination. Abstract translation of lecture at Leipsic, before the German Assn. of Gas and Water Engs. Deals with the developments of flame illumination during the last twenty years. 3000 w. Jour Gas Lgt—Feb. 22, 1898. Serial. 1st part. No. 18755 A.

Incandescent Lamps.

The Temperature of Incandescent Lamps. (Sur la Temperature des Lampes à Incandescence.) A paper by M. Janet giving the methods used for measuring the temperatures of the filaments. Tests of 4 lamps of 10 candle power at 65 volts gave temperatures between 1610° to 1720° C. 1200 w. Comptes Rendus. March 7, 1898. No. 19227 D.

Lamp Resistance.

A New Method of Determining the Resistance of Incandescent Electric Lamps. (Ueber Eine Neue Methode zur Bestimmung des Elektrischen Leitungwiderstandes Stromdurchflossender Glühlampen.) Drs. Apt and Hoffmann. A combination of two Wheatstone bridges and balancing resistances by means of which the resistance of incandescent lamps may be determined while the current is flowing. 2500 w. Elektrotech Zeitschr—Feb. 24, 1898. No. 19266 B.

London Stations.

London Electric Light Stations. Herbert C. Gunton. An analysis of some of the most important and representative systems, illustrating the methods of operation and the plant employed. Part first considers the system of the London Electric Supply Corporation. Ill. 2000 w. Elec Wld—March 5, 1898. Serial. 1st part. No. 18791.

Municipal Lighting.

Practical Hints on Starting a Municipal Electrical Department. J. J. Steinitz. Extracts from a paper read before the Falcon Works Engineering Society. Discusses the difference between a municipal and a company undertaking the work of a municipal electric engineer, &c. 3700 w. Elect'n, Lond—Feb. 18, 1898. No. 18738 A.

N. Y. Post Office.

The Lighting of the New York Federal Building. Illustrated description of the isolated plant lately installed in the United States custom house and post-office in New York. 1400 w. Elec Wld—March 26, 1898. No. 19097.

Rates.

Rates for Incandescent Lighting. E. L. Wells, Jr. Abstract of paper read at the joint meeting of the Texas and Mexican electrical associations, Laredo, Tex. Brief discussion of the two general methods of charging, and their modifications. 1000 w. Elec Wld—March 19, 1898. No. 19001.

Room Lighting.

Experiments in Room Illumination. I. C. Thompson. Gives an illustrated account of tests made to determine whether a room was sufficiently lighted. 1500 w. Elec Eng, N. Y. —March 17, 1898. No. 19004.

Small Town Plant.

The Electric Light Plant in the Small Town. Its Resources and Chances for Extension. J. R. Cravath. Suggestions to owners of plants in towns of two to five thousand inhabitants of the possibilities for increasing business. 2000 w. Elec Eng, N. Y.—March 10, 1898. No. 18901.

Spain.

Electrical Engineering in Spain: The Electric Lighting of Mazarron. Illustrated description of the system. 900 w. Elect'n, Lond—Feb. 25, 1898. No. 18863 A.

Switchboards.

Central Station Switchboards. F. A. C. Perrine. Extracts from a paper read before the San Francisco convention of the Pacific Coast Elec. Trans. Assn. Considers the material for the board, the circuits and the insulation employed, instruments installed and location. 2200 w. Elec Wld—March 26, 1898. No. 19098.

Toronto, Canada.

The New Works of the Toronto Electric Light Company. Illustrated description. 1200 w. Can Elec News—March, 1898. No. 18872.

200-Volt Circuits.

On the Manufacture of Lamps and Other Apparatus for 200-Volt Circuits. G. Binswanger Byng. Read before the Inst. of Elec. Engs., England. Describes the appliances now upon the market, or under manufacture, pointing out deficiencies, and giving writer's views. 2800 w. Elec Rev, Lond—Feb. 25, 1898. Serial. 1st part. No. 18845 A.

Wiring.

Free Wiring Systems. John H. Rider. Report to the Electricity Committee of Plymouth Corporation. Presents the methods of the Free Wiring Syndicate, Limited, and the advantages of the scheme. 1500 w. Elec Eng, Lond—March 18, 1898. No. 19156 A.

POWER.

Booster.

See Street and Electric Tramways.

Commutators.

See Street and Electric Tramways.

Crane.

See Mechanical Engineering, Shop & Foundry.

Dredges.

Electrically Operated Power Dredges. Illustrated description of machinery for mining developed by the Bennett Amalgamator Manufacturing Co. 2000 w. Elec Wld—March 5, 1898. No. 18788.

Eddy Currents.

Losses Due to Eddy Currents in the Pole Pieces of Electric Machines. William Baxter, Jr. Explains the cause of the difficulty and the best way to avoid it. Ill. 1700 w. Am Mach —March 17, 1898. No. 19021.

Electrical Generation.

The Steam Engine and the Dynamo—A Chapter in Evolution. Charles T. Child. A review of the reciprocal development of the engine and the dynamo in response to the demands of power-house practice. Each machine has acted to produce an improvement in the other. 3500 w. Engineering Magazine—April, 1898. No. 19297 B.

Electric Locomotive.

See Railway Affairs, Motive Power.

Fly-Wheel Dynamo.

M. Patin's New Fly-Wheel Dynamo. Illustrates and describes a somewhat novel type of dynamo in use in Paris. 800 w. Engr, Lond —March 18, 1898. No. 19166 A.

Hamburg.

The Electric Plant at the Hamburg Customs Warehouses. (Das Elektrizitätswerk an der Zollvereinsniederlage zu Hamburg.) J. H.

Kinbach. A full description of this important plant, with data of tests of the engines. There are five triple-expansion vertical Corliss engines, of 1200 h. p. each, directly connected to the generators. Atmospheric condensers with cooling towers are used. 5000 w. 1 plate. Zeitschr d Ver Deutschr Ing—March 12, 1898. No. 19253 D.

Mexico.

Notes on Mexico. (Notes sur le Mexique.) Ramon Fernandez de Arteaga. Especially describing the development of hydraulic power in the numerous mountain streams including the hydraulic electric power station at Régla, near Pachuca. 2500 w. Le Génie Civil—Feb. 19, 1898. No. 19212 D.

Mining Machinery.

See Mining and Metallurgy, Mining.

Monocyclic System.

Successful Monocyclic Power Distribution at Middletown, Ohio. An example of the introduction of this system into a direct-current station. Ill. 1000 w. Elec Eng, N. Y.—March 31, 1898. No. 19199.

Motor Design.

Considerations Governing the Design of the Crocker-Wheeler Direct-Connected Motors. Gano S. Dunn. Description of the construction adopted with a view to obtaining the desired output without too great an increase of size. Ill. 800 w. Elec Eng, N. Y.—March 31, 1898. Serial. 1st part. No. 19198.

Munich.

The New Electric Station at Munich. (Die Neuen Elektricitätswerke Münchens.) F. Uppenborn. A general description of this important plant, with plans of the buildings and a map of the city showing the location of the five substations with regard to the main power plant. 5000 w. Elektrotech Zeitschr—March 3, 1898. No. 19268 B.

Polyphase Motors.

See Street and Electric Tramways.

Power Plant.

The Butte, Montana, Power Plant. Illustrated description of a 6000 H. P. hydro-electric plant with steam relay and a 66-ft. timber dam. 900 w. Eng Rec—March 5, 1898. No. 18893.

The Dolgeville, N. Y., Electric Light and Power Plant. Data and illustrations of a plant for the generation of electricity for lighting, heating, &c. 1800 w. Elec Eng, N. Y.—March 17, 1898. No. 19003.

The Electric Power Plants in Reading, Pa. N. Monroe Hopkins. Illustrated description of the combined power plant of the Metropolitan Electric Co. and the United Traction Co. 2000 w. Elec Eng, N. Y.—March 10, 1898. No. 18900.

The Saint Anthony Falls Power Plant. Edward N. Saunders, Jr. Brief account of this plant built to furnish power for the street railways of St. Paul and Minneapolis. Ill. 1800 w. Yale Sci M—Feb., 1898. No. 18690 C.

Sparking.

Sparking, Its Cause and Effects. Thorburn Reid. Shows that the real injury is done before the segment leaves the brush, and discusses some of the ways in which imperfect commutation causes injury to the commutator, and how sparkless commutation may be assured. Discussion. 10000 w. Trans Am Inst of Elec Engs—Jan., 1898. No. 19008 D.

Starting.

A Simple Method of Starting Single Phase Alternating Current Motors. (Ein Einfaches Verfahren, um Asynchrone Einphasige Wechselstrommotoren zum Anlauf zu Bringen.) Riccardo Arno. Describes the use of an auxiliary resistance in connection with the armature. 2000 w. Elektrotech Zeitschr—Feb. 17, 1898. No. 19265 B.

Towing.

The Development of Electric Cableways. Richard Lamb. An illustrated account of the electric cableways, and their application to canal-boat towing. Also other uses to which they may be applied. Discussion. Ill. 11500 w. Trans Am Inst of Elec Engs—Jan., 1898. No. 19007 D.

Transmission.

The Newcastle-Sacramento Transmission. Illustrated description of one of the most interesting installations in the western part of the United States. 3300 w. Jour of Elec—Feb., 1898. No. 19052.

The Harnessing of the Missouri River Near Helena, Montana. Illustrated description of the latest installation in the Rocky Mountain region. 700 w. Elec Eng, N. Y.—March 31, 1898. No. 19197.

TELEGRAPHY AND TELEPHONY.

Cables.

A Graphical Method of Determining the Current in Submarine Cables. (Ueber ein Graphische Methode um den Stromverlauf in Unterseeischen Kabeln Darzustellen.) F. Rossel. The impulses are plotted graphically and the combination of the successive diagrams enables the entire current to be shown. 2000 w. Elektrotech Zeitschr—March 3, 1898. No. 19270 B.

The Empire and the Telegraph Cables. Discussing the subject of a system of submarine cables starting from England, and carried to various British possessions. 1100 w. Elec Rev, Lond—March 4, 1898. Serial. 1st part. No. 18969 A.

Construction.

Art of Constructing Telephone Apparatus. H. P. Clausen. A general review of what is being done by builders of telephone appliances. Ill. 3800 w. W Elect'n—Feb. 26, 1898. No. 18747.

Exchange.

Fort Wayne Telephone Exchange. Illustrated description. 700 w. W Elect'n—Feb. 26, 1898. No. 18746.

Measurement.

The Measurement of the Electrical Properties of Telephone Lines. Dr. V. Wietlisbach. Mathematical investigations. 900 w. Elec Engng—March 1, 1898. No. 18794.

Modern Telephones.

The Modern Telephone Instrument. Francis G. Hall, Jr. Describes the long-distance instrument. Ill. 2400 w. Yale Sci M—Feb., 1898. No. 18692 C.

Operation.

The Telephone Situation. J. J. Nate. Presents the various phases of the work, discussing the organization methods, equipment and exchange operation in part first. 2400 w. W Elect'n—March 12, 1898. Serial, 1st part. No. 18942.

Stockholm.

The Underground Telephone System in Stockholm. (Die Unterirdische Fernsprechanlage in Stockholm.) A Hultman. A general description of the system. The wires are drawn through holes in insulating blocks. Two articles. 5000 w. Elektrotech Zeitschr—Feb. 17, 24, 1898. No. 19263 each B.

Synchronograph.

Tests of the Synchronograph on the Telegraph Lines of the British Government. Albert Cushing Crehore and George Owen Squier. Gives a brief description of the Wheatstone instruments, and of the experiments made. Ill. 4500 w. Jour Fr Inst—March, 1898. Serial. 1st part. No. 18808 D.

Telephone Work.

Practical Features of Telephone Work. A. E. Dobbs. Suggestions for starting a new exchange, and the importance of having the advice of a competent superintendent who has had practical experience, are given in part first. 1800 w. Elec Eng, N. Y.—March 17, 1898. Serial, 1st part. No. 19005.

Telephote.

The Telephote. J. Warren. An instrument devoted to picture telegraphy. Its essential feature is a selenium cell, and the article considers mainly the nature and properties of this substance. 1400 w. Elec, Lond—Feb. 25, 1898. No. 18843 A.

MISCELLANY.

Accidents.

Death by Electricity. W. S. Hedley. A study of the causes that produce death by electricity with account of experiments on animals. 2000 w. Elec Rev, Lond—Feb. 18, 1898. No. 18735 A.

Accumulators.

The Dependence of the Electromotive Force and Efficiency of Accumulators upon the Strength of Acid. (Ueber die Abhängigkeit der Elektromotorischen Kraft und der Nutzeffectes des Bleiakkumulators von der Säurekonzentration.) F. Dolezalek. A mathematical discussion, the conclusions of which are confirmed by experimental tests. 3500 w. Zeitschr f Elektrochemie—Feb. 5, 1898. No. 19275 H.

Coil Winding.

Hints on the Windings of Magnet Coils. William Baxter, Jr. Shows that the greatest danger comes from attempts to crowd too many turns in a layer, and illustrates various defects. 1600 w. Am Mach—March 3, 1898. No. 18783.

Columbia University.

Electrical Engineering of Columbia University. F. B. Crocker. A description of the new buildings and their equipment. Ill. 2200 w. Elec Wld—March 12, 1898. No. 18899.

Diagrams.

Standard Diagrams for Uniformity in Electrical Engineering and Patent-Office Drawings. Diagrams approved and adopted by the Chicago Electrical Assn., Feb. 4, 1898. 1600 w. Elec Rev, N. Y.—March 2, 1898. No. 18752.

Disruptive Discharges.

On the Disruptive Discharge in Air and Liquid Dielectrics. T. W. Edmondson. Gives history of work in this field and describes experiments made, giving tabulated results. Ill. 4400 w. Phys Rev—Feb., 1898. No. 19030 D.

Photographic Investigation of 150,000-Volt Power Discharge. Charles Proteus Steinmetz. Investigation of the phenomena taking place during a disruptive discharge at a very high voltage and in a circuit of sufficient power to maintain an arc. Ill. 2200 w. Elec Wld—March 5, 1898. No. 18789.

Electrical Science.

The Development of Electrical Science. Thomas Gray. Address of the president, delivered before the annual meeting of the Indiana Academy of Sciences. 10300 w. Science—March 18 and 25, 1898. 2 parts. No. 19032 C.

Electro-Dynamics.

The Study of Electro-Dynamics. J. Warren. Considers each of the laws and phenomena propounded by Ampere relating to the action of active conductors upon one another. Ill. 1500 w. Elec, Lond—March 4, 1898. Serial. 1st part. No. 18972 A.

Electrometer.

The Kelvin Quadrant Electrometer as a Wattmeter and Voltmeter. Ernest Wilson. Gives the experience which the writer has gained with this instrument. 2000 w. Elec Rev, Lond—March 4, 1898. Serial. 1st part. No. 18970 A.

Galvanometer.

Practical Work with the Ballistic Galvanometer. Lawford H. Fry. Describes methods which facilitate work with this instrument. 1700 w. Elec Rev, Lond—March 4, 1898. No. 18968 A.

Hysteresis.

A Method of Determining Magnetic Hysteresis Loss in Straight Iron Strips. J. A. Fleming. Read before the Physical Society. Description of a process which is based upon the use of the bifilar reflecting wattmeter, and operates on samples of iron large or small, in the form of straight strips which are simply slipped into a long magnetizing coil. Ill. 2000 w. Elect'n, Lond—Feb. 25, 1898. Serial. 1st part. No. 18864 A.

Magnetism.

The Analogy of Action between Luminous Rays and Lines of Magnetic Force. (Sur une

Analogie d'Action entre les Rayons Lumineux et les Lignes de Force Magnetique.) A paper presented to the French Academy by M. Birkeland discussing some remarkable experiments made with a Crookes tube in a strongly magnetic field. The results are tabulated and shown in diagrams. 1800 w. Comptes Rendus—Feb. 21, 1898. No. 19225 D.

Toronto Magnetic Observatory. The history of the establishment, and report of the troubles arising from recent electric light circuits, electric cars, iron-frame buildings, &c. 1400 w. Can Eng—March, 1898. No. 18986.

Magnets.

Magnet Winding Curves. J. P. Stone. Gives curves by use of which the calculation of the space required for the winding is greatly facilitated. 500 w. Elec Eng, N. Y.—March 24, 1898. No. 19100.

Nickel Steel.

Investigations into the Magnetic Properties of Nickel Steel. (Recherches sur les Propriétés Magnétiques des Aciers au Nickel.) A paper by M. Eugene Dumont giving the magnetic permeability of various alloys at different temperatures. 1000 w. Comptes Rendus—March 7, 1898. No. 19229 D.

Oils.

On the Specific Inductive Capacity of Certain Oils. Arthur L. Clark. Describes investigations made by the use of Quincke's bubble method, giving results. 900 w. Phys Rev—Feb., 1898. No. 19031 D.

Resistance.

The Measurement of Fault Resistances with a Voltmeter. Stuart A. Russell. Describes several applications of the use of the voltmeter and calls attention to the results that may be obtained. 1800 w. Elec Rev, Lond—Feb. 25, 1898. No. 18844 A.

The Precise Comparison of Very Small Resistances. Samuel Sheldon. Outlines a method used with great success at the Polytechnic Institute for determining low resistances. Ill. 900 w. Elec Wld—March 5, 1898. No. 18790.

Supervision.

An Electrical Bureau. William Brophy. Address delivered before the International Assn. of Commissioners and Inspectors of Buildings, held at Detroit, Mich. On the advisability of organizing and maintaining such bureaus for the protection of life and property. 2100 w. Arch & Build—March 12, 1898. Serial. 1st part. No. 18921.

Switch.

Some Switch Devices for Laboratory Use. (Einige Schaltapparate für den Laboratoriumsgebrauch.) Dr. J. Kollert. Describing a form of revolving commutator, and various applications of it to laboratory work. 2000 w. Elektrotech Zeitschr—March 3, 1898. No. 19269 B.

Testing.

A 100,000-Volt Testing Set. C. E. Skinner. Gives general plan of apparatus made by the Westinghouse Electric & Manufacturing Co., for the Cataract Construction Co. of Niagara Falls, by means of which tests may be made at any E. M. F. from 1200 volts to 100,000 volts. Ill. 1800 w. Elec Wld—March 5, 1898. No. 18792.

Thermo-Electricity.

Contributions to the Thermoelectric Problem. (Zum Thermoelektrischen Problem.) A. Wilke. An examination of the action of heat upon the electrical state of a homogeneous body, in connection with the observations of Hall, v. Ettinghausen, and Nernst. 3500 w. Deutsche Zeitschr f Elektrotechnik—Jan. 15, Feb. 1, 1898. No. 19271 each E.

Transformer.

Separation of the Iron Losses of a Transformer. H. S. Carhart. A method based on the measurement of these combined losses at two frequencies. 600 w. Elec Wld—March 5, 1898. No. 18793.

Warfare.

Manifold Uses of Electricity in Time of War. From the *Boston Transcript*. Discusses the urgency of the formation of an electrical corps for the army and navy, as electrical devices are unfamiliar to any but trained experts. 1800 w. Bos Jour of Com—March 26, 1898. No. 19123.

X-Rays.

A Theory in Reference to the Origin and Character of X-Rays. George Adam. An attempt to account for the rays by the atomic theory. 1000 w. Elec Rev, N. Y.—March 9, 1898. No. 18885.

Remarks upon X-Ray Tubes. C. C. Hutchins. A review of the experiments that have been made in this field. 1500 w. Elec Rev, N. Y.—March 16, 1898. No. 18989.

MARINE ENGINEERING.

Ballasting.

The Ballasting of Steamers. Editorial on a resolution discussed in the House of Lords having for its object the regulation of the ballasting of steamers. The dangers of navigation in ballast are considered. 1700 w. Engr, Lond—Feb. 25, 1898. No. 18860 A.

Battleships.

British and Foreign Types of Battleships. Editorial calling attention to some features in the most important types of warships. 900 w. Engr, Lond—March 18, 1898. No. 19165 A.

Destruction of the U. S. Battleship Maine by an Explosion in Havana Harbor. Technical information of the construction and equipment of this vessel, with engravings illustrating the warship and her machinery. 8500 w. Marine Engng—March, 1898. No. 18916 C.

Boiler Furnaces.

The Causes of Collapse in Marine Boiler Furnaces. William R. Austin. Read before the Inst. of Engs. and Shipbuilders, Scotland.

States the known and assumed causes and gives a theory which the writer thinks may account for some unexplained cases. Ill. 3000 w. Prac Eng—March 4, 1898. No. 18984 A.

Cruiser.

The Spanish Cruiser "Cristobal Colon." Illustrated description with some interesting explanations relating to the rapid work. 2000 w. Engng—Feb. 18, 1898. No. 18729 A.

High Pressures.

High Pressures at Sea with Some Consideration of Types of Boilers. W. R. Cummins. From a paper read at the North-East Coast Inst. of Engs. & Shipbuilders, in Sunderland, England. Considers the theoretical economy of steam, and the type of boiler best suited to the new conditions. 2000 w. Marine Engng—March, 1898. Serial. 1st part. No. 18917 C.

Loading.

An Essay upon Methods of Loading. (Essai sur des Procédés d'Arrimage.) Devoted to the proper method of loading vessels with rails, and arranging cargo so as to avoid shifting; including the loading of wooden and iron ships and also iron steamers. Serial. Part 1. 4000 w. La Revue Technique—March 10, 1898. No. 19209 D.

Navigation.

Bech's Apparatus for Controlling the Course of a Vessel. (Der Bech'sche Schiffscurs-Controlapparat.) A combination of compass and photographic recording apparatus by means of which any deviation of a vessel from a given course is recorded and shown. 3500 w. Oesterr Monatschr f d Oeffent Baudienst. No. 19283 D.

Navy Estimates.

The Navy Estimates. Reviews the work for the coming year, the annual statement for last year, estimates and general matters connected with the navy. 2500 w. Engng—March 11, 1898. No. 19060 A.

Propulsion.

Propulsive Power. James N. Warrington. A comparison of the results of speed trials of several new ships, with explanation and tabulated calculations. 1200 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18823 H.

Rapid Construction.

Speed of Construction, a Vital Factor of Naval Strength. Frank B. King. Urging simplification of hull, machinery, fittings and armament, and other changes allowing economy of time. The application of the "unit principle," and changes tending to rapid building. 4800 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18827 H.

River Boats.

Steamboats for the Yukon Trade. Describes boats designed and built by Lewis Nixon to ply on the rivers of Alaska and South America, of interest because of their carrying capacity, light draft, and original features of design. Ill. 1200 w. R R Gaz—March 25, 1898. No. 19114.

The Modern Ohio River Boat. Hunter Morrison. Showing the improvements made in river boats and describing the "Queen City" owned by the Pittsburg & Cincinnati Packet line. Ill. 2000 w. Yale Sci M—March, 1898. No. 19014 C.

Shipbuilding.

An American Menace to British Shipbuilding. Editorial on an article by Andrew Carnegie in the *Iron Trade Review*, of Cleveland, urging the United States to regain the supremacy in shipbuilding. 1100 w. Ir & Coal Trds Rev—March 18, 1898. No. 19182 A.

German Shipping and Shipbuilding. Discusses the progress made, the development of the merchant marine, the sailing fleet, shipbuilding, &c. 2500 w. Engng—March 18, 1898. No. 19172 A.

How a Ship is Made. Max Hahn. Considers the construction of a modern ocean steamer. 1800 w. Chau—April, 1898. No. 19185 C.

Shipbuilding in 1897. Calls attention to the discrepancies found in published reports of various papers, and of Lloyd's Register, showing that it is useless to try to be very precise in reporting statistics. Gives general information of the amount of work done in British shipyards. 3000 w. Engr, Lond—Feb. 18, 1898. Serial. 1st part. No. 18721 A.

War-Ships Building on the Delaware. Henry Starr Richardson. Illustrations of the "Princeton," "Mackenzie," "Alabama" and "Kasagi," with brief remarks. 500 w. Harper's Wk—April 2, 1898. No. 19187.

Ship Power Plants.

See Mechanical Engineering, Transmission.

Steam Consumption.

Steam Consumption of the Main and Auxiliary Machinery of the U. S. S. Minneapolis. W. W. White. Prize essay. Full description of the apparatus for testing, the methods adopted, with tabulated results, discussion and plates. 30000 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18822 H.

Steamship Construction.

Recent Designs in Steamship Construction upon the Great Lakes. Richard L. Newman. Some of the difficulties are discussed, the position of machinery, the midship sections, &c. Discussion. Ill. 5400 w. Jour Assn of Engng Socs—Jan., 1898. No. 18697 C.

Submarine Boat.

Holland Submarine Boat. An illustrated descriptive article dealing with the main features of the boat which was invented by John P. Holland. 1800 w. Engr, N. Y.—March 15, 1898. No. 19009.

Trials.

Gun and Steam Trials of H. M. S. "Illustrious." An account of the trials which mark a distinct advance as a consequence of the introduction of many mechanical devices. 2000 w. Engng—March 18, 1898. No. 19171 A.

Speed and Power Trials of a Light-Draught Steam Launch. Charles Ward. Describes the boat and trials, giving tabulated results. 2500 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18829 H.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Furnaces.

See Marine Engineering.

Boiler Tests.

Boiler Testing with Various Fuels. David P. Jones. The writer has given this subject much attention and presents some of the results of his experience, with suggestions as to what may be the best methods to secure the best results. Ill. 7800 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18826 H.

Tests of a Corrugated Furnace "Gunboat Type" Boiler. Notes some of the features of the boiler and reports test, which gives results of more than usual interest. 1100 w. Eng News—March 3, 1898. No. 18771.

Test of Internally Fired Boiler at the Washington Mills. Gives the data of a test, noteworthy for the rapid combustion and high results obtained. 500 w. Eng Rec—March 5, 1898. No. 18894.

Trials of the Niclausse Safety Water-Tube Boiler. Jay M. Whitham. Illustrated description, dimensions of boiler, manner of testing, object and results. Also discussion. 6300 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18825 H.

Chimney.

See Architecture and Building, Construction.

Circulation.

A Study of the Circulation of Water in Multitubular Boilers. (Etude de la Circulation de l'Eau dans les Chaudières Multitubulaires.) H. Brillié. A mathematical and experimental treatment, especially relating to the nature and causes of circulation in water-tube boilers. Four articles. 10000 w. Le Génie Civil—Feb. 19, 26, March 5, 12, 1898. No. 19213 each D.

Combustion.

The Schlicht Method of Combustion. P. J. Schlicht. Describes the plan and reports practical results of this system. Ill. 1800 w. Elec Eng, N. Y.—March 17, 1898. No. 19006.

Furnace Gases.

The Econometer: A Gas Balance for Indicating Continuously the Proportion of Carbonic Acid Gas in the Flow of Furnace Gases. Report of the Institute, through its Committee on Science and the Arts, investigating the invention of Max Arndt, of Aix-la-Chapelle. Illustrates and describes the apparatus, and considers that its claims have been fully substantiated. 2500 w. Jour Fr Inst—March, 1898. No. 18811 D.

Grease Extractors.

The Location of Grease Extractors. William R. Billings. A criticism of statements made in editorial of this paper, giving the writer's experience. 900 w. Eng Rec—March 5, 1898. No. 18892.

High Pressures.

Some of the Practical Difficulties of the Higher Pressures. E. Richards. Reviews some of the difficulties that have had to be met by modern engineers, and details that require attention before future advance may be expected. 3300 w. Prac Eng—Feb. 25, 1898. No. 18839 A.

See Marine Engineering.

Incrustation.

Steam Boiler Incrustation. Recommending the use of sodium tannate. 800 w. Power—March, 1898. No. 18880.

Injectors.

Locomotive Injectors. George H. Baker. History of the invention and early use of injectors, with a discussion of its advantages over the pump, and the best injectors for locomotive service. 3000 w. Ry Mag—Jan., 1898. No. 18758.

Low Water.

Low Water in a Steam Boiler. (Manque d'Eau dans un Générateur de Vapeur.) C. Walckenaer. A discussion of a boiler explosion at Montreuil-sous Bois, with an account of experimental investigations into the causes of sudden fluctuations of water level and disappearance of water from the glass. 4000 w. 1 plate. Annales des Ponts et Chaussées, 3 Trimestre, 1897. No. 19237 F+G.

COMPRESSED AIR.

Efficiency.

Doubling the Efficiency of Compressed Air. Frank Richards. Presents a scheme for the more economical use of compressed air. 1800 w. Am Mach—March 24, 1898. No. 19095.

Gwin Mine.

Compressed Air at the Gwin Mine. E. A. Rix. From the Golden Jubilee edition of "The Mineral Resources of Calaveras County," California. Illustrates and describes an interesting and economic installation. 1700 w. Jour of Elec—Feb., 1898. No. 19053.

Indicator Diagrams.

The Analysis of Air-Compressor Indicator Diagrams. F. A. Halsey. Analysis of card submitted by a correspondent, with reply to questions asked. 1600 w. Am Mach—March 3, 1898. No. 18782.

Pneumatic Tools.

Shop Tools Driven by Compressed Air. Aiming to show the number and variety of tools which are now driven by compressed air. 700 w. Am Mach—March 24, 1898. Serial. 1st part. No. 19094.

The Boyer Hammer. Illustrated description of a pneumatic hammer, used for caulking, chipping, beading tubes, and other purposes. 4000 w. Engng—Feb. 25, 1898. No 18871 A.

Riveters.

See Shop and Foundry.

Rolling Mill.

Compressed Air in a Rolling Mill. Harry

M. Perry. Illustrated description of some of the applications at the Passaic Rolling Mill Co. of Paterson, N. J. 1000 w. Compressed Air —March, 1898. No. 19105.

ENGINES AND MOTORS.

Air Pump.

Vertical Air Pumps without Suction Valves. (Betrachtungen über die Stehenden Kondensator-Luftpumpen ohne Saugventile.) Karl Reinhardt. A mathematical discussion of an improved form of air pump for condensing engines. A very simple and effective design. 5000 w. Zeitschr d Ver Deutscher Ing—March 5, 1898. No. 19251 D.

Blowing Engines.

Notes on Blowing Engines. T. M. Grant. Abstract of paper read before the West of Scotland Iron & Steel Inst. Describes various types. 2300 w. Engr's Gaz—March, 1898. No. 18945 A.

Condensers.

Improved Condenser Installations. (Neuere Kondensationsanlagen.) A fully illustrated article showing existing installations of the Klein surface condensers with cooling towers. 1200 w. Glaser's Annalen—Feb. 15, 1898. No. 19279 D.

Diesel Motor.

The Diesel Motor. E. D. Meier. Reviews work of many mechanical engineers aiming to develop a perfect heat engine, and discusses the degree of success attained by each. Gives the principles of the Diesel motor, the results of tests made, and interesting general information. 7500 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18828 H.

The Diesel Motor. E. D. Meier. Some account of the work done in thermodynamics, especially the careful work of Rudolph Diesel, stating what the writer considers the underlying principle of this invention, and giving a short description of the motor as thus far developed. Ill. 1400 w. Jour Assn of Engng Socs—Jan., 1898. No. 18698 C.

The New Diesel Motor. (Diesel's Neue Wärmemotor.) A paper by Fritz Krauss, discussing the performance and theory of the Diesel motor in comparison with other heat engines. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—March 11, 1898. No. 19261 B.

Gas Engines.

Gas-Engine Research. Report of Frederic W. Burstall to the Gas-Engine Research Committee of the Inst. of Mech. Engs., England. Experiments to determine the effect produced on the economy of gas-engines by altering one or more of the conditions governing their working. Also discussion. 5200 w. Jour Gas Lgt—Feb. 22, 1898. No. 18756 A.

The Gas Engine in American Practice. George Richmond. Showing how the original devices imported from Europe have been modified by American builders and reviewing the present condition of gas engine practice in the United States. 4000 w. Engineering Magazine —April, 1898, No. 19298 B.

The Use of Lean Gases in Gas Engines. M. Lencauchez. Read before a session of the Société de l'Industrie Minerale. Reports conclusions from tests made at the Hoerde (Westphalia) Iron Works, and gives further information. 1500 w. Pro Age—March 15, 1898. No. 18994.

Governors.

The History of the Shaft Governor. Investigation of the subject, with illustrations. 2000 w. Eng News—March 17, 1898. No. 19024.

Keely Motor.

The Keely Motor. E. A. Scott. Describes a visit to Mr. Keely's laboratory and the experiments witnessed, with the conclusion that there was no evidence produced that a new form of force had been discovered. Ill. 10000 w. Pro Engs' Club of Phila—Jan., 1898. No. 18766 D.

Steam Consumption.

See Marine Engineering.

Valve Gears.

Valve Gear Design. Jas. Dunlop. The first of a series of articles treating of this subject designed to meet the requirements of engineers designing engines. Almost every type of engine is intended to be dealt with and the development of valve gears from their simplest to their more complicated forms illustrated. 2200 w. Prac Eng—Feb. 18, 1898. Serial. 1st part. No. 18731 A.

POWER AND TRANSMISSION.

Belts.

Belt Driving. John Tullis. Read at the West of Scotland Technical College Scientific Society. Deals with the manufacture, use, care, speed, &c., of belts, and subjects related. 2700 w. Prac Eng—March 18, 1898. Serial. 1st part. No. 19161 A.

Dynamometers.

Transmission Dynamometers. Samuel Webber. Describes various types, and the uses to which they are put, giving a simple explanation of the calculations involved. Ill. 2200 w. Mach, N. Y.—March, 1898. Serial. 1st part. No. 18878.

Elevators.

Safety Devices for Elevators. Howard Lee Davis. Illustrated description of some of the devices in use for retarding the speed and bringing the car to a standstill. 1700 w. Yale Sci M —March, 1898. No. 19013 C.

Ship Power Plants.

Central Power Plants on Board Ship vs. Distribution of Power. William S. Aldrich. Considers the advantages of having all the power required, developed in a single plant. Discusses steam, compressed air, water pressure and electricity. 3500 w. Jour Am Soc of Nav Engs—Feb., 1898. No. 18824 H.

Steel Cables.

Contract for Cables in Venezuela. Copy of a contract for the construction of steel cables between Valencia and other towns for the transpor-

tation of merchandise. 700 w. Cons Repts—March 23, 1898. No. 19099 D.

Transmission.

Transmission of Power. H. R. Sutton. Deals mainly with ways to overcome and to utilize the friction between working parts. 1500 w. Prac Eng—March 18, 1898. No. 19162 A.

Water Power.

The Rational Utilization of Waterfalls of Low Head. (L'Utilisation Rationelle des Chutes d'Eau de Faible Hauteur.) A discussion of the Von der Heydt current motor, showing the conditions of its best efficiency, and adaptation to heads of water too low for advantageous use with other motors. 3500 w. La Revue Technique—Feb. 25, 1895. No. 19204 D.

The Utilization of the Water-Power of the Rhine. C. Du Riche Preller. Considers the main features of an undertaking at Zurich for using the power of this river for lighting, industrial purposes, &c. 2000 w. Engng—March 11, 1898. No. 19059 A.

SHOP AND FOUNDRY.

Annealing.

Annealing Malleable Castings. Alexander Cairns. Read at meeting of Foundrymen's Assn., in Philadelphia. A description of the process with short discussion. 2800 w. Ir Age—March 10, 1898. No. 18898.

Brass Castings.

"Burning in" Brass Castings. C. Vickers. Directions and suggestions for "burning in" successfully. Ill. 1000 w. Mach, N. Y.—March, 1898. No. 18875.

Crane.

Electrical Crane used with the Hydraulic Riveter at the Kolomna Machine Works, Russia. (Elektrischer Kran zur Bedienung des Hydraulischen Nieters der Kolomnaer Machinenbaufabrik.) A. Müller. A special form of bridge crane with two trolleys operated by electric motors, and used in connection with a large Tweddell hydraulic riveter. 1200 w. Zeitschr d Ver Deutscher Ing—March 5, 1898. No. 19252 D.

Foundry Practice.

The Chemistry of Foundry Practice. Ernst A. Sjostëdt. Paper to be discussed at Montreal meeting of the Federated Canadian Mining Inst. Notes and facts concerning the chemical changes taking place in the cupola. 2500 w. Can Min Rev—Feb., 1898. No. 18717 C.

Furnace Gauging.

An Instrument for Gauging the Circularity of Boiler Furnaces and Cylinders, and Producing a Diagram. T. Messenger. Read before the North-East Coast Inst. of Engs. & Shipbuilders, in South Shields. Illustrated description of apparatus for internally gauging and testing the circularity of cylinders designed particularly for use with cylindrical furnaces. 1600 w. Ind & Ir—Feb. 25, 1898. No. 18837 A.

Gears.

A Bevel-Gear Computing Machine. An illustrated description of instrument for the determination of the various angles required in the construction of bevel gears. The design of James Gleason. 600 w. Am Mach—March 24, 1898. No. 19096.

The Warren Bevel-Gear Generating Machine. Illustrated description of a machine for the construction of the gears of the Columbia chainless wheel. 1000 w. Am Mach—March 24, 1898. No. 19091.

Gear Teeth.

The Best Form of Curve for Gear Teeth Profiles. Replies to a letter of inquiry sent to constructors in regard to preferred practice. 2000 w. Am Mach—March 17, 1898. No. 19018.

Grinding.

Machine Grinding. C. H. Norton. The care needed in the handling of these machines. 1600 w. Am Mach—March 10, 1898. No. 18905.

Hydraulic Jointing.

Machinery for Hydraulic Jointing. Illustrated detailed description of the machinery of this system of cycle frame making as manufactured by Johnson & Phillips, of Charlton, Kent. 900 w. Engr, Lond—Feb. 18, 1898. No. 18723 A.

Japan.

The Foundries of Japan. Irvin McDowell. A letter from Yokohama, giving much information of interest. 1600 w. Ir Trd Rev—March 24, 1898. No. 19120.

Keyseating.

Devices for Keyseating Hubs, Couplings, etc. (Die Herstellung der Keilnuten in Radnaben, Wellenkupplungen, usw.) Hermann Fischer. With numerous illustrations of machines for cutting keyways in pulley hubs, &c. English and American devices principally are shown. Two articles, 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 19, 26, 1898. No. 19248, each D.

Lathe Testing.

Testing the Accuracy of a Lathe Without Special Tools. Theodore H. Miller. Gives a very cheap and simple method, covering the points desirable to be tested. Ill. 1500 w. Am Mach—March 3, 1898. No. 18781.

Locomotive Crane.

A Five-Ton Locomotive Crane. Illustrated detailed description of a machine built by the Case Manufacturing Co., of Columbus, O., for use in mill yards, stone yards, or wherever suitable tracks are available. 1200 w. R R Gaz—March 18, 1898. No. 18998.

Lubrication.

Lubrication of Driving Journals. B. Discusses the best method of introducing oil to bearings. 1200 w. Am Eng & R R Jour—March, 1898. No. 18750 C.

Molding.

Multiple Molding. F. O. Farwell. Illustrated description of the writer's method. 1100 w. Foundry—March, 1898. No. 18939.

Molds.

A Mustard-Top Mold, and the Process of Making It. A. H. Cleaves. Illustrated detailed description. 1800 w. Am Mach—March 17, 1898. No. 19019.

Pig Iron.

Sandless Pig Iron. E. A. Uehling. Read before the Pittsburg Foundrymen's Assn. Showing the advantage of sandless, or machine made, pig iron, and its superiority. 4000 w. Ir Age—March 3, 1898. No. 18754.

Pulleys.

Pulley and Fly-Wheel Construction. Theodore F. Scheffler, Jr. Part first explains the method of calculation by an example. Tables will be given compiled from actual practice. Ill. 3000 w. Power—March, 1898. Serial. 1st part. No. 18879.

Riveters.

Pneumatic Percussion Riveters. An illustrated description of a machine now extensively used for bridge, boiler and structural work, for work previously done by hand. 1000 w. Eng News—March 3, 1898. No. 18773.

Screw Threads.

The Unification of Screw Threads Abroad. (L'Unification des Filetages à l'Etranger.) A report of a preliminary meeting held at Zurich to provide for an international convention for the discussion of a general unification of screw threads. 7500 w. Bulletin de la Société d'Encour—Feb., 1898. No. 19239 G.

Shop Costs.

An Effective System of Finding and Keeping Shop-Costs. Henry Roland. An exposition of the "job ticket" system demonstrating its simplicity and effectiveness in enabling accurate shop costs to be determined with the minimum of clerical work. 3500 w. Engineering Magazine—April, 1898. No. 19295 B.

Shop System.

A New Shop System. George D. Chapman. Describes the system in operation the past two years at the shops of the Fitchburg Machine Works, in Massachusetts, where tools are manufactured. Ill. 2200 w. Mach, N. Y.—March, 1898. No. 18876.

Swedish Machines.

A Swedish Worm Wheel Cutting Machine and a Swedish Lathe. John E. Sweet. Illustrates and describes an interesting machine for cutting accurate worm gears of any size and pitch. 900 w. Am Mach—March 10, 1898. No. 18902.

Tool Works.

The Niles Tool Works. History with illustrated detailed description of the present works in Cincinnati, O. 2500 w. Ir Age—March 24, 1898. No. 19118.

Watchmaking Tool.

Taper-Pin Turning Tool. A. H. Cleaves. Illustrates and describes a tool long in use in the watch business, for making regulator pins. 700 w. Am Mach—March 10, 1898. No. 18904.

MISCELLANY.

Ammunition Works.

Kynoch's Ammunition Works. Illustrated description of the Wilton Works, near Birmingham, Eng. 2200 w. Engng—March 4, 1898. No. 18949 A.

Automobiles.

Boilers for Motor Cars. Editorial advocating the use of steam for the propulsion of vehicles on common roads. 1500 w. Engr, Lond—March 4, 1898. No. 18955 A.

Experiments Concerning Steam Road-Vehicles, and the Conclusions Drawn from Them. D. H. Simpson and W. L. Bodman. Read before the Liverpool Centre of the Self-Propelled Traffic Assn. A statement of the difficulties to be overcome, the investigations made and conclusions. 6800 w. Ind & Ir—Feb. 25, 1898. No. 18838 A.

The Steering of the Motor-Car: An Interesting Study. C. A. Matthey. It is proposed to study the subject in a broad way pointing out the good and bad points in existing gears and endeavoring to indicate means of securing more satisfactory results. Ill. 2000 w. Ind & Ir—March 18, 1898. No. 19173 A.

Ballistics.

Ballistic Problems in Indirect and Curved Fire. James M. Ingalls. Mathematical discussion, giving formulas and tables. 4500 w. Jour of U. S. Artillery—Jan.-Feb., 1898. No. 18938 D.

Cold.

Linde's Method of Producing Extreme Cold and Liquefying Air. J. A. Ewing. Presents a novel process made known by Dr. Carl Linde, of Munich, for attaining extremely low temperatures and for liquefying air, and calls attention to the uses to which this product may be applied. Discussion. Ill. 6800 w. Jour Soc of Arts—March 11, 1898. No. 19033 A.

Drying.

The Physical Principles and Practical Construction of Modern Drying Plants. (Ueber die Physikalischen Grundlagen und die Technische Ausbildung Moderner Trockenanlagen.) Prof. P. Pfeifer. A general discussion of the principles involved in artificial drying, and an account of the methods of construction. 4000 w. Gesundheits Ingenieur—Feb. 15, 1898. No. 19285 B.

Education.

Technical Education. W. E. Ayrton. Verbatim report of an address delivered to the Coventry Technical Inst., England. 3500 w. Elec Eng, Lond—Feb. 25, 1898. No. 18819 A.

Heat Transmission.

See Architecture and Building, Heating.

Inventions.

Rights of Employers and Employés to Inventions of the Latter. D. Walter Brown. A statement of the principles that may be considered settled relating to this subject. 900 w. Am Mach—March 10, 1898. No. 18903.

Kites.

Kites: Their Theory and Practice. B. F. S.

Baden-Powell. Information from the practical experience of the writer, with investigation of the theoretical principles, and discussion. Ill. 8000 w. Jour Soc of Arts—March 4, 1898. No. 18924 A.

Muscular Force.

The Influence of Frequency and Weight upon the Maximum Power of the Muscles. (De l'Influence de la Fréquence des Mouvements et du Poids Soulevé sur la Puissance Maximum du Muscle.) A paper presented to the French Academy by MM. Broca and Richet, with valuable data and diagrams of muscular effort. 1200 w. Comptes Rendus—Feb. 7, 1898. No. 19223 D.

The Influence of Intermittent Periods of Repose and Effort upon the Average Power of the Muscles. (De l'Influence des Intermittences de Repos et de Travail sur la Puissance Moyenne du Muscle.) A further contribution by MM. Broca and Richet to the French Academy upon the subject of muscular power. 1800 w. Comptes Rendus—Feb. 28, 1898. No. 19226 D.

Ordnance.

Heavy Ordnance. Osborne Atwater Day. Reviews the progress made, especially since the Civil War. 1800 w. Yale Sci M—March, 1898. No. 19015 C.

Paper Making.

The Recent History of Paper Making. Clayton Beadle. Traces briefly some of the important changes in paper making during the past hundred years. Ill. 7500 w. Jour Soc of Arts—March 18, 1898. No. 19153 A.

Pipe Coverings.

I. Experimental Determination of the Efficiency of Pipe Coverings. F. G. Gasche. Reprint from *Power* of Dec., 1896. II. The Heat-Insulating Properties of Different Steam Pipe Coverings. Tests made by F. J. Emery and J. H. Godfrey. Also other reported tests. 6500 w. N Y R R Club—Feb. 17, 1898. No. 18977 D.

Printing.

The Severy Impression Process. Melvin L. Severy. Describes a new method of printing. 4300 w. Jour Fr Inst—March, 1898. No. 18809 D.

Pump Test.

Test of Centrifugal Pump and Calibration of Weir at the Bridgeport Pumping Station, Chicago, Ill. R. C. Carpenter. Description of plant and method of testing, with results of the test of various pumps and of the calibration of the large weir. Ill. 4500 w. Sib Jour of Engng—March, 1898. No. 19081 C.

Rams.

Hydraulic Rams. J. Richards. Illustrates and describes the work of the writer in this field, showing the improvements made and yet to be desired, and giving much information of value. Also discussion. 8000 w. Jour Assn of Engng Socs—Jan., 1898. No. 18695 C.

Refrigeration.

The Theory and Practice of Mechanical Refrigeration. T. R. Murray. Read Dec. 21, 1897, before the Inst. of Engs. and Shipbuilders in Scotland. A brief description and analysis, from an engineering point of view, of the theory of the subject, and of the application of that theory to practice. 1800 w. Engr, Lond—Feb. 18, 1898. Serial. 1st part. No. 18725 A.

Rubber.

The Drying of Washed India-Rubber. A discussion of the rubber-drying process. 1600 w. Engng—Feb. 25, 1898. No. 18870 A.

Screw Fastenings.

Screw-Threaded Fastenings. G. D. Rice. Gives various forms of devices for keeping nuts and set screws from working loose. Ill. 800 w. Dom Engng—March, 1898. No. 19056 C.

Sewing Machines.

Sewing Machinery. F. W. Brady. Gives the early history, account of first patent, the principles of the chain-stitch and lock-stitch machines and other information. Ill. 2000 w. Mach, N. Y.—March, 1898. No. 18877.

Steam Pressure.

Drop of Steam Pressure in Elbows and Valves. E. C. Sickles. Gives results deduced from recent experiments, compare with the values commonly used to determine the drop in steam pressure for elbows and valves. 800 w. Sib Jour of Engng—March, 1898. No. 19082 C.

Steam Shovel.

The Thew Steam Shovel. Illustrates and describes a machine designed especially for loading iron ore from stack piles into modern high railway cars, but also useful in various kinds of work. 1100 w. Ry & Engng Rev—March 19, 1898. No. 19077.

Testing.

The International Congress for Testing Materials, held at Stockholm, 1897. (Ueber den Congress des Internationalen Verbandes für Materialprüfung in Stockholm.) Prof. F. Kick. Devoted mainly to a discussion of the work of internal friction in materials subjected to deformation, with a review of the theories of Prof. Rejto. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 18, 1898. No. 19254 B.

Time Recorder.

The Bundy Time Recorder. Illustrated detailed description of a machine for registering the actual time a workman enters and leaves the works. 1300 w. Engr, Lond.—March 11, 1898. No. 19063 A.

Vacuum.

A Hermetic Emptying Device. (Le Verseur Hermétique.) A description of the de Sennevoy device by means of which any desired amount of liquid may be drawn from a vessel without permitting the entrance of air or other substance. 1200 w. La Revue Technique—March 10, 1898. No. 19208 D.

Wire.

Wire and Wire-Making. S. Barnett. Part first gives a report of the proposed combination of all the wire interests of the United States, discussing the production and uses of this product. 2300 w. Eng & Min Jour—March 26, 1898. Serial. 1st part. No. 19125.

MINING AND METALLURGY.

COAL AND COKE.

Alaska.

Alaskan Coal Fields and Mines. An account of mines already known and the quality of the coal. Ills. & Map. 1800 w. Ir & Coal Trds Rev—Feb. 25, 1898. No. 18851 A.

Anthracite.

A Successful Experiment in Anthracite Mining. William Tate. Reports a visit to the Richards Mine of the Union Coal Co., near Mt. Carmel, Pa., giving an account of the method of obtaining 90% of the coal in pitching veins. 1800 w. Mines & Min—March, 1898. Serial. 1st part. No. 18933 C.

Early Anthracite Coal Mining in Pennsylvania. John D. Estabrook. Extracts from a paper read before the Civil Engs.' Society of St. Paul. An account of early work in Schuylkill Co., Penna. 1400 w. Ry & Engng Rev—March 26, 1898. No. 19193.

Carboniferous Deposits.

The Life Zones of the Carboniferous Deposits of Europe. Dr. Wheelton Hind, in the *Geological Magazine*. A comparison of the life zones already established in Russia and Belgium, and as far as possible contrasting the distributing of fossils with that which is found in Great Britain. 3500 w. Col Guard—March 11, 1898. No. 19066 A.

The Mineralogy of the Carboniferous. Henry S. Poole. Paper to be discussed at the Montreal meeting of the Federated Canadian Mining Inst. Notes the presence of mineral infiltrations in addition to the regular stratified deposits of this formation. 1500 w. Can Min Rev—Feb., 1898. No. 18715 C.

China.

The Coal Fields of China. From the London *Times*. Giving information and claiming that China belongs in the front rank of coal-producing countries. 2000 w. Col Guard—March 18, 1898. No. 19180 A.

The Coalfields of Schantung. Baron von Richthofen. Brief account of the deposits of this district. 800 w. Col Guard—March 11, 1898. No. 19065 A.

Coke.

The Coke Country. H. P. Snyder, Gives the history of the coke industry, and especially of the Connellsville (Pa.) region. 3000 w. Chau—April, 1898. No. 19184 C.

Explosions.

The Chemistry of Colliery Explosions Due to Gas Derived from Coal-Dust. Donald M. D. Stuart. Read before the Phys. & Chem. Section of the Bristol (Eng.) Naturalists Society. Reviews what has been learned by investigation and observation, with conclusions. 6500 w. Col Guard—March 18, 1898. No. 19179 A.

Fan.

Farcot Fan at a Belgian Colliery. Victor Watteyne. From a report on the plant and methods of mine working at the Brussels Exhibition, and also an article in *L'Industrie* of Brussels. Illustrated description. 1500 w. Col Guard—March 11, 1898. No. 19064 A.

India.

Coal Mining in India. Myles Brown. From a paper contributed to the British Soc. of Mining Students. The manner of working, appliances used, conditions of the coal trade, &c. 1800 w. Col Guard—March 4, 1898. No. 18954 A.

Umaria Colliery. Description with plan and information concerning output, earnings, &c. 1000 w. Ind Engng—Feb. 12, 1898. Serial. 1st part. No. 19028 D.

Mining Machinery.

Coal Mining by Machinery. M. E. Part first discusses the difficulties of the application of coal cutting machines in England. 1200 w. Prac Eng—March 11, 1898. Serial. 1st part. No. 19076 A.

Origin.

The Origin of Coal. E. Bertrand. Abstract of a lecture delivered in France, dealing with this subject. 1400 w. Col Guard—March 18, 1898. No. 19174 A.

Pennsylvania.

Pennsylvania Coal Statistics for 1897. Authentic and reliable data, given in tabulated form. 1000 w. Mines & Min—March, 1898. No. 18936 C.

Semi-Bituminous.

The Heating Value of Semi-Bituminous Coals. Editorial discussing the possible errors which is apt to cause the apparent heating value of the coal to be less than the true value, and so make the reported "efficiency" of a steam boiler erroneous. 1600 w. Eng News—March 24, 1898. No. 19086.

Under-Clays.

The Manufacture of Fireclay Goods from the Under-clays of Thin Coal Seams. Philip Kirkup. Read at meeting of Fed. Inst. of Min. Engs., at Newcastle-on-Tyne. Presents the importance of utilizing any by-product possible, to assist in the profitable working of a colliery, especially in the working of thin seams, and gives general description of articles made from fireclay. 3500 w. Col Guard—March 5, 1898. No. 18853 A.

Wallsend Colliery.

Historical Notes on Wallsend Colliery, England. T. E. Forster. The Re-opening of Wallsend Colliery. Henry Ayton. Two papers read at meeting of Fed. Inst. of Min. Engs., at Newcastle on-Tyne, concerning an interesting and valuable colliery. 3800 w. Col Guard—Feb. 25, 1898. No. 18854 A.

Washing.

Coal Washing. William B. Phillips. From advance sheets of second edition of "Iron Making in Alabama." Reviews the history of the industry in this state and gives information of changes effected by washing, and results ob-

tained. 3300 w. Am Mfr & Ir Wld—March 25, 1898. No. 19137.

COPPER.

Colorado.

Colorado's Copper Output. A report of the yield of mines of the Paradox Vall y, in the La Sal Mountains. 2000 w. Min Ind & Rev—March 10, 1898. No 18975.

Mexico.

A New Copper Deposit in Mexico. Ernest du B. Lukis. A report of the mine known as La Aurora, in the State of Puebla, Mexico. 1200 w. Eng & Min Jour—March 5, 1898. No. 18848.

Mining Points of Interest in Mexico. A. F. Wuench. Gives an account of the Velardena district, the state of Jalisco, and of a copper and molybdenum mine. 2300 w. Min Ind & Rev —March 10, 1898. No. 18973.

New Mexico.

Copper Deposits of Mora County, New Mexico. W. L. Austin. Abstract of a paper read before the Colorado Scientific Soc., in Denver. Describes these deposits and gives the writer's explanation of their probable origin. Not of commercial value. 900 w. Eng & Min Jour—March 26, 1898. No. 19124.

GOLD AND SILVER.

Alaska.

Alaska and Its Mineral Resources. Arthur Lakes. Abstract from the *Alaska Mining Record*. The geographical situation of the mining districts with account of their discovery, the development work, and the conditions under which the work must be done. 2500 w. Mines & Min—March, 1898. No. 18934 C.

Gold Deposits, Geology and Geography of Alaska. Information from a U. S. Government pamphlet prepared by W. H. Dall and F. C. Schrader, and edited by S. F. Emmons. 4500 w. Min & Sci Pr—March 19, 1898. Serial. 1st part. No. 19122.

Gold Fields of Alaska: Rush of Prospectors. Reports the large number of prospectors already on the Pacific coast en route for these gold fields, and comments on the movements of Canada aiming to securing as large benefits as possible from the discovery. 800 w. Cons Repts—March 11, 1898. No. 18922.

The Yukon Mining Region. Charles G. Yale. The conditions at present existing, the high price of living and transportation, the severity of the climate, and the expectations are discussed. 2300 w. Min Ind & Rev—March 10, 1898. No. 18974.

Australia.

Northern Goldfields, W. A. S. J. Becher. Part first describes the fields of Pilbarra and West Pilbarra. Ill. 1100 w. Aust Min Stand —Jan. 20, 1898. Serial. 1st part. No. 18961 B.

Notes on the Geology and Mineral Deposits of West Australia. E. F. Pittman. Read before the Australasian Assn. for the Advancement of Science. Descriptive. 6500 w. Aust Min Stand—Jan. 27 & Feb. 10, 1898. Two parts. No. 18987 E.

Cyanid Process.

Chemistry of the Cyanid Process. Reviews the theories which have been formulated to explain how gold becomes dissolved in this process. 2200 w. Min & Sci Pr—March 12, 1898. No. 19011.

The Stamp Milling of Gold Ores in its Relation to Cyaniding. Discussion of paper by E. H. Johnson. 4400 w. Chem & Met Soc of S. Africa—Jan. 29, 1898. No. 18929 D.

Fusion.

The Melting Points of Silver and Gold. (Sur les Points de Fusion de l'Argent et de l'Or.) New determinations by M. Berthelot, together with comparisons of his results with those of other authorities since 1863. The results are 962° C. for silver, and 1064° C. for gold. 1500 w. Comptes Rendus — Feb. 7, 1898. No. 19222 D.

Hungary.

The Gold-Silver Mines in Kapnik, Hungary. R. Helmhacker. Describes the deposit, and the extraction process in use. 4200 w Min & Sci Pr—March 12, 1898. No. 19010.

Klondike.

The River Trip to the Klondike. John Sidney Webb. Interesting account of the country and life of the miners, with some information of method of mining, &c. Ill. 12000 w. Century Mag—March, 1898. No. 18743 D.

The Rush to the Klondike over the Mountain Passes. Edward S. Curtis. Brief account of the difficulties encountered on this route in 1897. Ill. 1400 w. Century Mag—March, 1898. No. 18744 D.

The Rush to the Klondike. Sam Stone Bush. An article on the present output and future promise of Alaska's new gold fields, by an observer. Gives characteristics of the country, methods of mining and living, &c. Ill. 12000 w. Am Rev of Revs—March, 1898. No. 18785 C.

Ore Bodies.

Rosita and Silver Cliff. Arthur Lakes. The peculiar forms of the ore formation found in the necks of old volcanoes in Colorado; what they are composed of and the means by which they were deposited. Ill. 3300 w. Mines & Min—March, 1898. No. 18935 C.

River Mining.

River Mining in California. R. L. Dunn. Considers the appliances for working, and the subject generally. 4800 w. Min & Sci Pr—March 19, 1898. No. 19121.

Sierra Nevada.

The Primary Gold Deposits of the Sierra Nevada. Waldemar Lindgren. Information of the age, occurrence, character and forms of the deposit, with conclusions relating to their origin. 3300 w. Engng Jour—Feb., 1898. No. 18913 C.

Smelting.

Recent Smelting Practice in Colorado. L. S. Austin. Improvements in the practice of smelting, confined to the so-called lead and copper

smelters, where these metals are used for collectors of gold and silver in the ores. 3000 w. Eng & Min Jour—March 5, 1898. No. 18849.

The Possibilities of Smelting in B. C. R. A. Hedley. Paper to be discussed at the Montreal meeting of the Federated Canadian Mining Inst. The opinions of the writer, based on a knowledge of the country and a study of its ores. 1500 w. Can Min Rev—Feb., 1898. No. 18714 C.

Tailings.

The Treatment of Tailings by the Direct-Filling Process. F. Cardell Pengilly. Abstract of a paper read before the Inst. of Min. and Met., London. Describes this method as used successfully at mines on the Witwatersrand. 1000 w. Eng & Min Jour—March 19, 1898. No. 19041.

Transvaal.

Auriferous Conglomerate of the Transvaal. George F. Becker. A consideration of the nature of this wonderful deposit, and the theories advanced to account for the deposition. 7800 w. Am Jour of Sci—March, 1898. No. 18761 D.

Witwatersrand.

Mining the Gold Ores of the Witwatersand. H. H. Webb, Pope Yeatman. A general account of the methods employed in dealing with the mining problems of this field, with many illustrations of the plant at the leading mines, and a description of the machinery used. 4000 w. Engineering Magazine—April, 1898. No. 19292 B.

IRON AND STEEL.

Blast Furnaces.

Destruction of Blast-Furnace Lining by Carbon. F. W. Luermann. Translated from *Stahl und Eisen*. Considers it due to iron pyrites in the fire clay, and the furnace gases entering the brick. 1200 w. Am Mfr & Ir Wld—March 11, 1898. No. 18988.

Blowing Engines.

See Mechanical Engineering, Power.

Hard Steel.

The Use of Steel. Editorial concerning the increasing use of harder and harder varieties of steel. 1200 w. Engng—March 4, 1898. No. 18950 A.

Iron Ore.

The Deposits of Oolitic Iron Ore in the New Basin of Briey. (Les Gisements de Minerais de Fer Oolithiques du Nouveau Bassin de Briey, Meurthe-et-Moselle.) G. Rolland. An account of the development of these new sources of iron ore in the north-eastern part of France. 1500 w. Moniteur Industrielle—Feb. 12, 1898. No. 19240 G.

Nickel Steel.

Investigations upon Nickel Steel. (Recherches sur les Aciers au Nickel.) A paper by M. Guillaume discussing the behavior of various alloys at different temperatures. 1000 w. Comptes Rendus—March 7, 1898. No. 19228 D.

Nickel Steel for Crank Pins and Axles. H. F. J. Porter. Condensed. Gives results of tests, and shows that this metal possesses valuable qualities, and insures a combination of elastic strength and ductility. 2000 w. Am Mach—March 24, 1898. No. 19093.

Ore Washers.

Removal of Sand from Waste Water of Ore Washers. J. E. Johnson, Jr. Abstract of a paper read before the Am. Inst. of Min. Engs., at the Atlantic City meeting. Illustrates and describes the machine used at the plant of the Longdale Iron Co., in Virginia. 1200 w. Eng & Min Jour—March 12, 1898. No. 18930.

Pig Iron.

See Mechanical Engineering, Shop & Foundry.

Rolling Mills.

Modern Rolling Mills. John S. Hunting. Read before the West of Scotland Iron and Steel Inst. Mentions different types of mills, discusses methods, and suggests considerations necessary in the construction and working of steel mills. 2500 w. Col Guard—March 18, 1898. No. 19178 A.

Steel.

Acid vs. Basic Steel. The views of two leading manufacturers as to the reliability of the two processes. 1300 w. Ir Age—March 10, 1898. No. 18897.

Thin Sheets.

To Distinguish Iron from Steel When in Thin Sheets. Gus C. Henning. Ten tests are given, in response to an inquiry. 1600 w. Am Mach—March 24, 1898. No. 19092.

Toughening.

The Coffin Toughening Process. L. R. Pomeroy. From a paper presented at the Feb. meeting of the Western Railway Club. This process of toughening steel is described, its advantages discussed, and tests reported. 1600 w. R R Gaz—March 18, 1898. No. 18999.

MINING.

Canadian Mining.

Mr. Hamilton Smith on Canadian Mining Regulations. Extracts from a letter published in the Montreal *Star* containing much of interest in regard to the mining regulations for the Yukon district. 1200 w. Eng & Min Jour—March 19, 1898. No. 19040.

Deep Pits.

The Installation of Very Deep Pits. (Installation des Puits à Grande Profondeur.) E. Tomson. Devoted to the equipment of deep pits, including the winding machinery, headworks, cages, rails, &c.; especially in respect to the practice of the Dortmund district. 15000 w. 3 plates. Revue Universelle des Mines—Feb., 1898. No. 19262 H.

Explosives.

Improvements in Safety Explosives. E. M. Hann. Read before the South Wales Inst. of Engineers. Deals with experiments carried out during the last three years, describing the apparatus used. 1500 w. Col Guard—March 18, 1898. No. 19177 A.

The Manufacture of Nitro-Explosives. August Prister. Discusses the manufacture of nitro-glycerine, and different kinds of dynamite. 5600 w. Chem & Met Soc of S Africa—Jan. 15, 1898. No. 18807 D.

Firedamp.

Explosives and Firedamp in Austria. (Les Explosifs et le Grisou en Autriche.) A review of the work of the Austrian government Commission upon the action of mining explosives in igniting firedamp. Two articles. 4500 w. Le Génie Civil—March 5, 12, 1898. No. 19218 each D.

Researches upon the Explosion of Gaseous Mixtures by Electric Currents. (Recherches sur l'Explosion des Mélanges Grisouteux par les Courants Electriques.) Paper by MM. Couriot and Meunier relating the results of experiments to determine the igniting effect of incandescent wires and electric sparks upon mixtures of air and firedamp. 1200 w. Comptes Rendus—March 7, 1898. No. 19230 D.

Miners' Outfits.

Canadian Duties on Miners' Outfits. A copy of the instructions issued to customs officers. 900 w. Cons Repts—March 24, 1898. No. 19101 D.

Mining Labor.

See Economics and Industry, Labor.

Mining Law.

Appointment of Receiver and Manager of Mines. British law as applied to this subject, illustrated by special cases. 1800 w. Col Guard—March 4, 1898. No. 18952 A.

New Canadian Mining Regulations. A copy of the new regulations issued by the Interior Department of Canada, governing mining in the Yukon regions. 5500 w. Cons Repts—March 10, 1898. No. 18906 D.

The Law as to Dredging in Rivers for Gold. R. W. Raymond. Some information on points bearing upon this subject. 900 w. Eng & Min Jour—March 5, 1898. No. 18847.

Mining Machinery.

An Interesting Electric Mining Plant. Illustrated description of plant near Wilkesbarre, Pa. 1200 w. Elec Rev, N. Y.—March 6, 1898. No. 18990.

Electricity in Mining Operations. F. A. C. Perrine. A review of the present applications in this field and of the improvements needed. 2000 w. Engng Jour—Feb., 1898. No. 18914 C.

Some Considerations Affecting the Design of Mining Motors. F. C. Caldwell. Read before the Ohio Inst. of Mining Engs. Calls attention to some points to be borne in mind in deciding on the claims to excellence of any machine. 2300 w. Am Mfr & Ir Wld—March 25, 1898. No. 19136.

Some Modern Forms of Mining Machinery. Frederick T. Snyder. Paper to be discussed at the Montreal meeting of the Federated Canadian Mining Inst. Describes machinery designed to meet specific conditions of the gold ores of the Lake of the Woods, many of which are low in grade, but contain streaks of high values. Ill. 3000 w. Can Min Rev—Feb., 1898. No. 18713C.

Shafts.

Notes on Shaft Sinking. W. Teague. Read before the Inst. of Min. & Met., England. Favors round shafts and states their advantages; briefly considers ventilation, size, and inclined shafts. 1200 w. Col Guard—Feb. 25, 1898. No. 18856 A.

Training.

Technical Training in Mining. Henry Louis. Read at meeting of Federated Inst. of Min. Engs., at Newcastle-on-Tyne. An examination of the principles that should form the basis of a sound mining education. Discussion. 4700 w. Col Guard—Feb. 25, 1898. No. 18852 A.

Ventilation.

Mine Atmosphere. From the *Cours d'Exploitation des Mines*, by M. Haton de la Goupillière. Considers both the temperature and chemical composition, the regulation of the air supply, and effect on the workers. 4700 w. Col Guard—Feb. 25, 1898. No. 18855 A.

Water Motors.

Small Water Motors for Mines. George D. Rice. Shows several forms of simple motors, with details of making. Ill. 800 w. Eng & Min Jour—March 5, 1898, No. 18850.

MISCELLANY.

Aluminum.

Notes on Aluminum. Jesse M. Smith. Much information of this metal, its properties, uses, cost, &c. with discussion. 11000 w. Jour Assn of Engng Socs—Jan., 1898. No. 18694 C.

Bessemer.

A Metallurgical Revolutionist. Brief review of the life and many inventions of Sir Henry Bessemer. 1500 w. Transport—March 18, 1898. No. 19160 A.

Sir Henry Bessemer. Sketch of his life and work. 2200 w. Engr, Lond—March 18, 1898. No. 19164 A.

The Late Sir Henry Bessemer. An account of the interesting career of this well-known metallurgist, with portrait. Ill. 6000 w. Ir. & Coal Trds Rev—March 18, 1898. No. 19181 A.

The Late Sir Henry Bessemer. Biographical sketch with some of the episodes of his career. 3500 w. Engng—March 18, 1898. No. 19170 A.

British Columbia.

The Mineral Act of British Columbia. R. W. Raymond. Considers various points of the law, especially the size of claims, the proof of their mineral value, and the manner of their demarkation. 2000 w. Can Min Rev—Feb., 1898. No. 18712 C.

Coal Ash.

Fusibility of Coal Ash Determined by Its Composition. Eugène Prost. Showing that the fusibility of an ash depends upon the relation between the flux and the silica and alumina. 800 w. Col Guard—March 18, 1898. No. 19175 A.

Exposition.

Notes on the Exposition of 1900. (A Propos de l'Exposition de 1900.) Giving some account

of the progress in coal mining during the century, as it will be shown at the coming exposition. 2000 w. La Revue Technique—Feb. 10, 1898. No. 19202 D.

Glass Works.

The Glass Works of Val Saint-Lambert. (Les Cristalleries du Val Saint-Lambert.) A general descriptive account of the great glass works of Belgium, where 4500 employés are engaged in the production of the finest cut-glass ware. 3000 w. La Revue Technique—Feb. 25, 1898. No. 19203 D.

Helena, Mont.

The Geology of Helena, Montana, and Vicinity. L. S. Griswold. A detailed account of the geology of this city and its relation to the region roundabout, with conclusions. 7000 w. Jour Assn of Engng Socs—Jan., 1898. No. 18696 C.

Manganese.

Manganese Mining in New Brunswick. Describes the deposits of bog manganese, and the method of treatment necessary to make it useful for commercial purposes. 1800 w. Cons Repts—March 24, 1898. No. 19102 D.

Manjak.

Occurrence and Mining of Manjak in Barbadoes, West Indies. Walter Merivale. Read at meeting of the North of England Inst. of Min. & Mech. Engs., at Newcastle-upon-Tyne. Abstract. Manjak is one of the bitumens. Its manner of deposit is described. 1000 w. Ir & Coal Trds Rev—Feb. 18, 1898. No. 18728 A.

Miners' Food.

Some Concentrated Foods for Miners, Prospectors and Explorers. J. T. Donald. Paper to be discussed at the Montreal meeting of the Federated Canadian Mining Inst. Presents information concerning concentrated foods which have been used by explorers with satisfactory results. 1500 w. Can Min Rev—Feb., 1898. No. 18716 C.

Petroleum.

How to Utilize the Waste Products of Petroleum Refineries. R. Zaloziecki. Calls attention to the money loss from failing to utilize this waste, also the harm from allowing it to poison water-courses. Gives various methods employed in different places. 2000 w. Am Mfr & Ir Wld—Feb. 25, 1898. No. 18706.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene (Acétylène). Illustrated description of the improved acetylene generator of the *Société Internationale de l'Acétylène*, with data as to the advantages of this illuminant, both for train lighting and stationary service. 1500 w. La Revue Technique—Feb. 25, 1898. No. 19206 D.

Acetylene. W. H. Tozer. Describes the gas and its production from calcic carbid, and considers its prospects. 2000 w. Prac Eng—March 4, 1898. No. 18983 A.

Acetylene Gas: Its Generation and Use. Thomas Glover. Read before the Midland Assn. of Gas Managers. Refers to the manufacture, makes a comparison of cost as a supply for light and heat, describes generating apparatus, &c. 1800 w. Gas Wld—Feb. 26, 1898. No. 18841 A.

Acetylene Gas, the New Illuminant. C. T. Marshall. Read at meeting of the Northern Arch. Assn., Newcastle, Eng. Brief history of the gas and its generation. 2400 w. Arch, Lond—March 11, 1898. No. 19074 A.

Acetylene Lighting at Vienna. From *Journal für Gasbeleuchtung*. Describes the arrangement for lighting the Franzenplatzes both by illuminating gas and acetylene. Ill. 700 w. Pro Age—March 15, 1898. No. 18993.

Acetylene Regulations for New York. Requirements of the N. Y. Board of Fire Underwriters for the installation of acetylene gas generators and for the storage of a limited supply of calcium carbid. 900 w. Pro Age—March 1, 1898. No. 18779.

Burners for Acetylene. Abstract translation of articles by Dr. Paul Wolff, published in the *Zeitschrift für Beleuchtungswesen*, giving tests of various burners, and some information on the illuminating value of this gas. 2000 w. Jour of Gas Lgt—March 1, 1898. No. 18964 A.

Address.

Inaugural Address before the Manchester District Institution of Gas Managers. W. S. Haddock. Considers many matters connected with the gas industry. 4000 w. Jour Gas Lgt—March 1, 1898. No. 18963 A.

Inaugural Address of J. T. Lewis before the Midland Assn. of Gas Managers, in Birmingham, Eng. Considers the labor problem, progress made in the carbonizing of coal for gas, coal handling in the retort house, &c. 8500 w. Gas Wld—Feb. 26, 1898. No. 18840 A.

Alignment.

Effect of Deflection in Alignment on the Flow of Gas in Street Mains. G. A. Hyde. Read before the Ohio Gas Lgt Assn. Shows that right-angle deflections are objectionable and should be avoided. Ill. 800 w. Am Gas Lgt Jour—March 28, 1898. No. 19142.

Ammonia.

Sulphate of Ammonia in Farming. John Hunter. Presents the merits of sulphate of ammonia in agriculture, as based on results obtained on the Dalmeny farms of Lord Rosebery. 2200 w.—Gas Wld—March 12, 1898. No. 19070 A.

Burners.

Some Incandescent Burners. N. W. Gifford. Read at meeting of New Eng. Assn. of Gas Engs. An account of tests made by the writer. Discussion. 7400 w. Am Gas Lgt Jour—March 7, 1898. No. 18862.

Competition.

How to Avoid Competition in a Small Town. E. G. Schmidt. Read before the Ohio Gas Light Assn. Gives the experiences of the Sandusky (O.) Gas Lgt Co. and recommends the combining of the electric light and gas interests. 2500 w. Am Gas Lgt Jour—March 28, 1898. No. 19138.

Distribution.

The Distribution of Gas. D. Coats Niven. A reply to criticisms by Messrs. Skinner and Canning on a previous article of the writer. 2200 w. Jour of Gas Lgt—March 15, 1898. No. 19126 A.

Dry Mains.

An Experience with Dry Mains. H. Kendrick. Read at meeting of Manchester Dist. Inst. of Gas Engrs. (England). Describes the plant at Stretford, the stoppages, the system in use, with its advantages and disadvantages. Also discussion. 4700 w. Gas Wld—March 5, 1898. No. 18956 A.

European Gas.

Some Notes on European Gas Matters. Walter S. Allen. Read before the New England Assn. of Gas Engs. Impressions received during a visit to Europe, noting matters of interest at various points. Discussion. 8500 w. Am Gas Lgt Jour—March 7, 1898. No. 18861.

Gasholders.

A Curious Old Gasholder. Describes an old American gasholder. Ill. 700 w. Am Gas Lgt Jour—Feb. 28, 1898. No. 18710.

Gasholder Construction. H. A. Allyn. Read before the New England Assn. of Gas Engs. Considers the determining of capacity, whether the holder shall be covered, materials to be used, and other details. Discussion. 9500 w. Am Gas Lgt Jour—Feb. 28, 1898. No. 18709.

Illumination.

Diffused Illumination. William Hallock. Some points on illumination in general, with consideration of the application of diffused illumination in the lighting of Columbia University Library. Ill. 1300 w. Pro Age—March 1, 1898. No. 18778.

Incandescent Lamp.

Lighting with Acetylene and Spirit Incandescent Lamps. (Ueber Acetylen-und Spiritus-Glühlicht-Beleuchtung.) A paper by Herr Gerdes, before the society of mechanical engineers, comparing acetylene with the light from alcohol incandescent lamps; with discussion. 3000 w. Glaser's Annalen—Feb. 15, 1898. No. 19278 D.

Incandescents.

The War of the Incandescents: Gas Versus Electric. J. H. Maxon. Read before the Ohio Gas Lgt. Assn. Suggests the means and presents the importance of pushing the sale of the best incandescent gas burners. 2000 w. Am Gas Lgt Jour—March 28, 1898. No. 19139.

London Gas.

London Gas: Its Supply and Quality. An account of the manner in which the gas supplied is tested to ascertain its lighting power, purity, and pressure. 2200 w. Builder—March 5, 1898. No. 18958 A.

Municipal Lighting.

See Electrical Engineering, Lighting.

Purifying.

A Closed Purifying Vessel. Henry G. Beatley. Read at meeting of the Mich. Gas Assn., at Port Huron, Mich. Presents the apparatus and discusses some of the advantages to be derived from its use. Ill. 3000 w. Pro Age—March 1, 1898. No. 18777.

Still Another Purifying Box. Irvin Butterworth. Read before the Ohio Gas Lgt. Assn. Illustrated description of the Doherty-Butterworth, or "Simplex" box, with a statement of some of the advantages. 3000 w. Am Gas Lgt Jour—March 28, 1898. No. 19140.

Regulating.

Regulating the Addition of Air to Gas. Herr Irminger. Shows how the amount may be easily regulated by means of a small rotary exhauster. 800 w. Jour of Gas Lgt—March 15, 1898. No. 19127 A.

Retorts.

The Construction of Inclined Gas-Retorts, Charging Apparatus, and Conveying Machinery. Maurice Graham. Read before the Birmingham (Eng.) Assn. of Mech. Engs. Discusses the most efficacious means for the transmission of coal and its carbonization in gas-works. Ill. 5500 w. Jour of Gas Lgt—March 15, 1898. Serial. 1st part. No. 19129 A.

Revivifier.

Comparative Results With or Without the Use of a Continuous Oxid Revivifier. Moses Coombs. Read before the Ohio Gas Lgt. Assn. Gives a statement of results showing the improvement obtained by the use of a continuous oxid revivifier. Ill. 1200 w. Am Gas Lgt Jour—March 28, 1898. No. 19141.

Spent Oxid.

The Valuation of Spent Oxid. Dr. Lubberger, in *Journal für Gasbeleuchtung*. Showing that it is often valued solely on the basis of the amount of prussian blue which it contains, and the methods of estimating, with other particulars. 1100 w. Jour of Gas Lgt—March 15, 1898. No. 19128 A.

Tar.

The Utilization of Coal Tar by Distillation. Edward J. Elles. Read at meeting of Mich. Gas Assn. at Port Huron, Mich. Data relating to the production of pitch, light and heavy oils and ammoniacal liquor obtained from actual results by the distillation of coal tar from the plant of the Detroit Gas Co. Ill. 3200 w. Pro Age—March 1, 1898. No. 18776.

Welsbach.

Experiments with the Welsbach Lamp. F. H. Hess. Read at meeting of the Mich. Gas Assn. at Port Huron, Mich. Considers the fundamental principles upon which a perfectly burning lamp depend, and points out some of the errors to be avoided in the manipulation of a Welsbach lamp. 3800 w. Pro Age—March 1, 1898. No. 18775.

SEWERAGE.

Liernur System.

The Liernur System in Amsterdam. (Das Liernur System in Amsterdam.) An illustrated account of the working of the Liernur pneumatic sewerage system in Amsterdam, where it has been in successful operation since 1870. 1000 w. Glaser's Annalen—March 1, 1898. No. 19281 D.

Pipe Sewers.

Flushing in Pipe Sewers. H. N. Ogden. Considers the subject carefully and the hydraulic problem involved, giving much needed information on the use of flush-tanks. 4400 w. Pro of Am Soc of Civ Engs—March, 1898. No. 19109 F.

Purification.

Sewage Purification by Intermittent Filtration at Spencer, Mass. Information of this plant with details of the sewage-screening chamber. 1500 w. Eng News—March 24, 1898. No. 19085.

Seine.

The Sanitation of the Seine. (L'Assainisement de la Seine.) G. Bechmann. A very full review of the sewage works nearly completed; which take all the sewerage of Paris, formerly discharged into the Seine, and deliver it to the sewage farms of Achères. Details of the important aqueduct and siphon work are given. A valuable paper. 7500 w. Bulletin de la Société d'Encour—Feb., 1898. No. 19238 G.

Sewage Farm.

The Sewage Farm of Achères, Paris. An article prepared from data contained in a very full description by the engineers in charge, published in the "Annales des Ponts et Chaussées." 3500 w. Eng News—March 17, 1898. No. 19022.

STREETS AND PAVEMENTS.

Brick Paving.

Paving Bricks. T. C. Hopkins. Gives brief history of the use of bricks for this purpose, the materials and essential properties, the testing, and a comparison with other materials. 2000 w. Engng Jour—Feb., 1898. No. 81-915 C.

WATER SUPPLY.

Air Leaks.

Handling Air in a Tube Well Pumping Plant. D. N. Tower. A brief description of the Cohasset water works, near Boston, and the writer's experience in fighting air leaks in the wells and suction mains of a driven well supply. 2400 w. Jour of N Eng Water Works Assn—March, 1898. No. 18817 F.

Artesian Supply.

Artesian Water Supply of Galveston, Tex. R. H. Peek. Describes a system consisting of 30 artesian wells, 27 being 7 ins. and three being 9 ins. in diameter, connected by an influent pipe directly with the 30-in. conduit to the receiving tank. Ill. 1900 w. Eng News—March 3, 1898. No. 18768.

Checking Waste.

The Water Supply Problem in Washington, D. C. Explains methods of utilizing present supply to better advantage by checking waste. 1800 w. Eng Rec—March 12, 1898. No. 18925.

Cleaning Mains.

Water Main Cleaning in St. John, N. B. Describes the mechanical scraper used and the method of cleaning. 1800 w. Can Eng—March, 1898. No. 18985.

Dam.

A Rock-Fill Dam with a Steel Heartwall at Otay, Cal. One of the three reservoirs for the water-supply of San Diego. The construction is illustrated and described. 3700 w. Eng News—March 10, 1898. No. 18909.

See also Civil Engineering, Irrigation.

Domestic Supply.

Purification of Domestic Water Supply. Homer T. Yaryan. The writer proposes to heat every drop of water to 230° F. for seven minutes before it enters the mains. 14000 w. Engr, N. Y.—March 1, 1898. No. 18780.

Filling.

Back Filling Trenches. E. A. W. Hammatt. Calls attention to points from the experience of the writer, and discusses the manner of back filling to be recommended. Discussion follows. 6000 w. Jour of N Eng Water Works Assn—March, 1898. No. 18815 F.

Back Filling Trenches. E. H. Gowing. Considers the expense of doing the work as it should be done. Also discussion. 6400 w. Jour of the N Eng Water Works Assn—March, 1898. No. 18816 F.

Filtration.

A Russian View of Mechanical Filtration. Nicholas P. Simin. Gives recommendations for improvements which have been hinted many times by engineers, although never before printed. 800 w. Eng Rec—March 19, 1898. No. 19038.

Flow.

The Flow of Water in Pipes. E. Sherman Gould. Considers only pipes of 1000 diameters and upward in length. 1800 w. Am Mach—March 3, 1898. No. 18784.

High-Pressure System.

The Separate High-Pressure Fire Service System at Providence, R. I. Information of this recently completed work, the area covered, length of pipe, pressure, cost, &c. Ill. 1100 w. Eng News—March 24, 1898. No. 19089.

Jersey City, N. J.

Jersey City's Water Supply. An editorial explanation of the manner in which this city's water supply is gradually passing into the control of private companies. 2500 w. Eng Rec—March 19, 1898. No. 19034.

Kingston, N. Y.

The Kingston, N. Y., Water-Works. Describes a 40,000,000 gallon reservoir and mechanical filter plant. Ill. 2000 w. Eng Rec—March 19, 1898. No. 19037.

Newport, N. H.

Construction of the Newport, N. H., Water Works. Lucian A. Taylor. Describes the works. Discussion. 3500 w. Jour of N Eng Water Works Assn—March, 1898. No. 18813 F.

Philadelphia.

The Water Supply Crisis at Philadelphia. Editorial on the plan of turning over the water-supply to a private corporation, setting forth the facts and commenting unfavorably. 2400w. Eng News—March 3, 1898. No. 18772.

Pumping Engine.

Test of the Triple Expansion Pumping Engine at the St. Gall Waterworks. (Versuche an einer Dreistufigen Dampf-Pumpmaschine im Wasserwerke der Stadt St. Gallen.) A full account of the tests made by Prof. Stodola of this fine Sulzer pumping engine; a steam consumption as low as 11.2 pounds per h. p. hour was attained. Three articles. 10000 w. Zeitschr d Ver Deutscher Ing—Feb. 19, 26, March 5, 1898. No. 19247 each D.

Reservoirs.

Reservoir Embankments, with Suggestions for Avoiding and Remedying Failures. William Fox. Read before the Soc. of Engs., London. General remarks followed by description of difficulties and means adopted to overcome them. The subject is confined to embankments constructed across natural valleys. Ill. 5000 w. Ind & Ir—March 11, 1898. No. 19042 A.

The Worcester Distributing Reservoir. Walter E. Hassam. Brief description of work undertaken with view to the future supply of water to the fast-growing city of Worcester, Mass. Ill. 1800 w. Jour of N Eng Water Works Assn—March, 1898. No. 18814 F.

River Crossing.

Placing a 10-Inch High-Service Pipe Across a River. Frederick W. Gow. Describes the method of crossing the Mystic river, at Medford, Mass. Discussion. 4000 w. Jour of N Eng Water Works Assn—March, 1898. No. 18818 F.

San Francisco, Cal.

Water Supply of San Francisco. Brief account of this works and history of the supply since 1855. 1200 w. Fire & Water—March 12, 1898. No. 18937.

San Jose, Cal.

Water Supply of San Jose, Cal. Henry A. Brainard. Brief description of the system, whose principal source of supply is found in mountain streams fed by strong springs. 1000 w. Fire & Water—March 26, 1898. No. 19134.

Savannah, Ga.

The Restoration of the Water Supply at Savannah, Georgia. Thomas T. Johnson. An account of steps taken to restore what appeared to be a decaying artesian water supply. Ill. 6000 w. Jour of W Soc of Engs—Dec., 1897. No. 18805 D.

Standpipe.

Erection of the Flushing Standpipe. Illustrates a floating stage inside the tank and raised by pumping water into the space below it as the work progresses. 1800 w. Eng Rec—March 26, 1898. No. 19131.

Steubenville, O.

Water System of Steubenville, Ohio. Part first gives a brief historical review of the water-works systems dating back to 1810, with illustrations. 900 w. Fire & Water—March 5, 1898. Serial. 1st part. No. 18820.

Syracuse Rules.

Rules of Syracuse (N. Y.) Water Department. A copy of the rules and regulations which must be signed by all water takers. 2000 w. Fire & Water—March 26, 1898. Serial. 1st part. No. 19135.

Town Supplies.

Springs and Wells for Town Supplies. H. W. Pearson. Extracts from paper read at meeting of British Assn. of Water Works Engineers, with résumé of discussion. 5000 w. Jour Gas Lgt—Feb. 22, 1898. No. 18757 A.

Valparaiso.

Works for the Supply of Potable Water to Valparaiso, Chili. (Travaux d'Adduction d'Eau Potable à Valparaiso, Chili.) A. Marquand. Describing the dam, reservoir and aqueduct recently completed. A supply of over 22,000,000 gallons per day is rendered available by gravity from Penuelas, 12 miles distant. 3500 w. 1 plate. Le Génie Civil—March 12, 1898. No. 19220 D.

Water Analysis.

The Interpretation of Sanitary Water Analyses. Floyd Davis. A discussion of the questions which must be considered in drawing conclusions from sanitary water analyses, both chemical and microscopical, both with regard to the evidences of safety and the detection of pollution. 3500 w. Engineering Magazine—April, 1898. No. 19294 B.

Water Question.

The Water Question in the Borough of Queens, New York. Reviews the water supplies of the various plants within this territory, discussing their condition and how to supply abundance of potable water when needed. 2200 w. Fire & Water—March 19, 1898. No. 19057.

MISCELLANY.

Dust Van.

Motor Dust-Vans. T. W. E. Higgens' report to the vestry of the parish of Chelsea, on the purchase of motor dust-vans. 3000 w. Elec Eng, Lond—March 18, 1898. No. 19157 A.

Garbage.

A Test of a Refuse Crematory. Describes a test of a plant at Leyton, England, which burns about 1700 tons of refuse and sewage sludge annually, the heated gases being used under two 96 h. p. boilers. 800 w. Eng Rec—March 5, 1898. No. 18891.

The Use of Garbage as Fuel. Explanation of conditions of hygienic cremation of garbage which render the process of doubtful utility in connection with commercially operated boilers. 9000 w. Eng Rec—March 5, 1898. No. 18887.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Notes on Railway Accidents. (A Propos des Accidents de Chemins de Fer.) Léo Dex. A classification of accidents by their causes, and a critical discussion of the best means of prevention. 1800 w. La Revue Technique—Feb. 10, 1898. No. 19201 D.

Train Accidents in the United States in January. Detailed list and classified summary. 4500 w. R R Gaz—March 11, 1898. No. 18941.

Train Accidents in the United States in February. Detailed list and classified summary, with remarks. 3000 w. R R Gaz—March 25, 1898. No. 19116.

American Railways.

An English View of Our Railways. W. M. Acworth. Gives impressions of a recent visit. 3300 w. Ry Age—Feb. 25, 1898. No. 18708.

FINANCIAL.

Car Accounts.

Car Accounts Without Books. Illustrates and describes the system of car accounting, invented by W. E. Beecham, recently adopted on the Chicago, Milwaukee and St. Paul Ry. 1400 w. Ry Age—March 25, 1898. No. 19191.

Earnings.

February's Good Railroad Earnings. Report for the month giving comparative tables. 1800 w. Bradstreet's—March 12, 1898. No. 18943.

Pennsylvania's Year of Improvement. Synopsis of report for 1897, with editorial. 4000 w. Bradstreet's—March 5, 1898. No. 18796.

Graphic Records.

Graphic Methods as Applied to Railway Records. Tracy Lyon. Read before the Northwest Ry. Club. Describes the method and demonstrates its value. 1800 w. Ry & Engng Rev—March 26, 1898. No. 19192.

LEGAL.

Coupler Decision.

The Latest Car Coupler Decision. Decision of the U. S. Circuit Court of Appeals in the case of the St. Louis Car Coupler Co. vs. the National Malleable Castings Co. over an alleged infringement of patents. Ill. 2000 w. Ry Age—March 25, 1898. No. 19190.

Freight.

The Law Respecting Freight for the Carriage of Coal. British law concerning the principles relating to contracts of affreightment, illustrated by cases. 4000 w. Col Guard—March 4, 1898. No. 18953 A.

Ireland.

Irish Railway Property. Information upon the finances of the three trunk companies which represent largely the railway network of the country. 1400 w. Engng—Feb. 25, 1898. No. 18868 A.

Nebraska Case.

Has the Supreme Court Pronounced the Nebraska Law Unconstitutional? Editorial discussion of Justice Harlan's decision. 1800 w. R R Gaz—March 18, 1898. No. 19000.

MOTIVE POWER AND EQUIPMENT.

Bogie Truck.

Discussion of a Bogie Truck for Passenger Cars on the Great Western Railway of England. George L. Fowler. A complete set of illustrations of a bogie truck for passenger cars that is built at Swindon, Eng., with discussion of the design. 6600 w. R R Car Jour—March, 1898. No. 18919.

Car Construction.

Car Designing and Construction. A. M. Waitt. Abstract of a lecture before the engineering students of Purdue University, dealing with the design of freight cars. 1000 w. Ry Age—March 25, 1898. No. 19189.

Coal Cars.

New Coal Cars of 80,000 lbs. Capacity—Illinois Central Railroad. Illustrated detailed description of low-draft coal cars 800 w. Ry & Engng Rev—March 12, 1898. No. 18991.

Concord Shops.

See Permanent Way and Fixtures.

Freight Cars.

Springs for Freight Car Trucks. H. C. McCarty. Committee report of results of investigation of the question of "Coil Springs for Freight Car Trucks." Ill. 1800 w. Cent Ry Club—Jan., 1898. No. 18765 D.

Electric Locomotive.

Austrian Narrow Gage Electric Locomotive. Illustrates and describes a locomotive built for the brewery of Dr. Schaup, intended for hauling two or three freight trailers, as well as conveying passengers, back and forth from the brewery to the railroad station. 1100 w. Elec Eng, N. Y.—March 3, 1898. No. 18763.

Grate Area.

How Large Can Grate Area Be Made Advantageously? Editorial discussing the action of the Erie Railway Co. in employing engines with Wootten fire-boxes over the main line of their system. 1400 w. Loc Engng—March, 1898. No. 18740 C.

Headlights.

Electric Headlights for Locomotives. Discussing the advantages and the objections. 1600 w. R R Gaz—March 11, 1898. No. 18940.

Instruction Car.

The Michigan Central Air-brake Instruction Car. W. W. White. Illustrated description. 600 w. Loc Engng—March, 1898. No. 18742 C.

Locomotive Handling.

The Economical Handling of Locomotives. Eugene McAuliffe. Observation and experience of the writer, with suggestions for lessening the

cost of operation of locomotives. 1200 w. Loc Engng—March, 1898. No. 18741 C.

Locomotives.

A New Express Engine on the Caledonian Railway. Charles Rous-Marten. Particulars of a new express engine of excellent design, the work of J. F. McIntosh. Ill. 2000 w. Engr, Lond—Feb. 25, 1898. No. 18857 A.

Economical Locomotives. G. W. Rhodes. Extracts from an address at a recent meeting of the St. Louis Railway Club, on the economical locomotive and its relation to the track. 1300 w. Am Eng & R R Jour—March, 1898. No. 18751 C.

Evolution of the Locomotive. John S. Thurman. History of the locomotive with illustrations showing the advancement. 6800 w. Ry Mag—Jan., 1898. No. 18759.

Four-cylinder Locomotives, and the Expansion Ratio for Compound Engines. (Viercylindrige Lokomotiven und die Füllungsverhältnisse bei Verbunddampfmaschinen.) Inspector Leitzmann. With many diagrams, and a general analytical investigation of the conditions of expansion in compound locomotives. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 19, 1898. No. 19249 D.

Ten-Wheel Passenger Locomotive; Atchison, Topeka and Santa Fé Ry. Description with dimensions and two-page plate. 1100 w. Eng News—March 3, 1898. No. 18770.

The Construction of a Modern Locomotive. Part first is introductory to a series of articles dealing with the modern methods of construction of a machine capable of the higher speed, greater trainload, and other requirements made necessary by close competition. Ill. 3800 w. Am Eng & R R Jour—March, 1898. Serial. 1st part. No. 18749 C.

Twelve-Wheel Locomotive—Chicago and Eastern Illinois Railroad. Half-tone and side elevation with general dimensions and particulars. 700 w. Loc Engng—March, 1898. No. 18739 C.

Utility and Characteristics of Locomotive Laggings. Wallace W. Johnson. Considers the subject of non-heat-conducting boiler and cylinder laggings and the loss of heat by radiation. Also discussion. 8500 w. N Y R R Club—Feb. 17, 1898. No. 18976 D.

Motor Car.

The Baldwin Motor Car for the C. H. & D. Traction Company. Illustrated detailed description. 400 w. R R Gaz—March 4, 1898. No. 18797.

Speed Trials.

Notable Speed Trials of British Locomotives. Charles Rous-Marten. A fully illustrated account of British high-speed locomotives with records of speed trials, showing the manner in which records in England have been made and broken under the stimulus of competition. 4500 w. Engineering Magazine—April, 1898. No. 19296 B.

Tools.

Special Tools; Fitchburg (Mass.) Car Shops. The application of compressed air for the operation of various tools is described, and other economical methods of doing work. Ill. 2300 w. R R Car Jour—March, 1898. No. 18920.

Train Lighting.

The Electrical Lighting of Mail Cars. (Die Elektrische Beleuchtung von Bahnpostwagen.) Editorial comments on the results of accumulator lighting during four years' experience in Germany. The lamps are changed after about 200 hours' use. The cost is about 3½ pfennigs per lamp hour at 12 candle power. 1200 w. Elektrotech Zeitschr—Feb. 24, 1898. No. 19267 B.

Train Resistance.

Train Resistance. A discussion of this subject, especially of the way in which it varies with the speed. 2300 w. Engr, Lond—Feb. 18, 1898. No. 18722 A.

NEW PROJECTS.

Africa.

Railway Building in German East-Africa. (Eisenbahnbau in Deutsch Ostafrika.) With map, profiles and an account of existing and proposed work; the roads will ultimately connect the Zanzibar coast with lakes Tanganyika and Victoria Nyanza. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1898. No. 19246 D.

China.

Modern China from an Engineer's Point of View. Part first considers railways and railway projects, reviewing the steps already taken. Ill. 3000 w. Engr, Lond—March 18, 1898. Serial. 1st part. No. 19163 A.

Railway Prospects in China. Editorial review of the progress being made. 3400 w. Engng—March 18, 1898. No. 19169 A.

Extension.

The Crows Nest Pass Extension of the Canadian Pacific Ry. An account of a line being built to open communication between the mineral regions of British Columbia and the Canadian Pacific system. Map. 1300 w. Eng News—March 10, 1898. No. 18911.

Lagos.

Lagos. Interesting information of this British colony of West Africa, and of the railway in process of construction. Ill. 3700 w. Engr, Lond—Feb. 25, 1898. No. 18859 A.

Madagascar.

The Madagascar Railway. (Le Chemin-de-Fer de Madagascar.) Editorial discussion of the need of railway communication in the new colony, with estimates of cost and statements of the valuable developments which would follow. 1200 w. Moniteur Industriel—Feb. 19, 1898. No. 19241 G.

New Trunk Line.

A New Trunk Line to New York. Discusses a proposed line from Chicago to New York. Map. 700 w. Ry Age—Feb. 25, 1898. No. 18707.

Uganda.

The Uganda Railway. An interesting general account of the line. 2500 w. Ind Engng—Feb. 19, 1898. No. 19152 D.

PERMANENT WAY AND FIXTURES.

Boston Station.

The Back Bay Station of the New York, New Haven & Hartford at Boston. Illustrated description of interesting features, with general information. 1500 w. R R Gaz—March 18, 1898. No. 18996.

China.

The Northern Railways of China. (Die Nördlichen Chinesischen Staatsbahnen.) With illustrations of bridges, tunnels, and rolling stock of the Tientsin-Peking railway, and the Kaiping coal mines and coke ovens. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 25, 1898. No. 19258 B.

Concord Shops.

Concord Shops—Boston & Maine Railroad. Some of the features of the locomotive shops and planing mill. Plans of the buildings, and also views of interiors including the powerful electric traveling cranes, are also given. Ill. 3800 w. Am Eng & R R Jour—March, 1898. No. 18748 C.

Mountain Road.

The Railway from Fayet to Chamounix. (Le Chemin de Fer du Fayet à Chamonix.) Illustrated description of combined adhesion and rack railway, opening communication by rail from Geneva to Chamounix, and from the latter to the Swiss frontier. 2500 w. La Revue Technique—Feb. 10, 1898. No. 19200 D.

Puebla Station.

Puebla Station, Interoceanic Railway of Mexico. Plan of the Puebla Yard and view of the recently completed station with brief remarks. 400 w. Ry & Engng Rev—March 26, 1898. No. 19194.

Rack.

Recent Rack Railways. (Neuere Zahnradbahnen.) E. Brückmann. Illustrated descriptive account of some of the latest roads and rolling stock, including the Damascus, Snowdon, Berner, Wengernalp, Gaisberg, Padang, Gornergrat, Jungfrau and other roads. Serial. 3 parts. 1 plate. 6500 w. Zeitschr d Ver Deutscher Ing—Feb. 12, March 5, 12, 1898. No. 19243 each D

See also Street and Electric Tramways.

Rails.

Rails and their Resistances in Railway Service. (Du Rail et sa Résistance dans les Voies.) G. Vinot. A discussion of the rail as a manufactured product, of its strength, and its capacity to resist the various shocks and stresses to which it is subjected. Serial. Part 1. 2500 w. La Revue Technique—March 10, 1898. No. 19211 D.

Road Bed.

Improvements in the Permanent Way of the Railways of Germany. (Zur Verbesserung des Oberbaues auf Deutschen Eisenbahnen.) A paper by Prof. Goehring before the railway society with illustrations of improved fastenings, rail joints and track construction. Serial. Part 1. 8000 w. Glaser's Annalen—March 1, 1898. No. 19280 each D.

Signalling.

Operation and Maintenance of the Block System on Single Track; C., N. O. & T. P. Ry. W. A. D. Short. Abstract of a paper read at the Pittsburg meeting of the Ry. Signalling Club. Considers the combination of the telegraphic block and the automatic electric block; also the electric train-staff system. 4000 w. Eng News—March 10, 1898. No. 18910.

Snow Protection.

The February Snow Storm in Massachusetts. George W. Blodgett. Calls attention to the great damage done by this unusually heavy storm, and suggests the placing of the railroad wires underground, as rapidly as possible. 1800 w. R R Gaz—March 25, 1898. No. 19113.

Statistics.

The World's Railways. Diagram showing the distribution of the railways of the world, with explanation. 500 w. Engng—March 18, 1898. No. 19167 A.

Terminal Facilities.

Improvement of the Terminal Facilities at the Port of New York. Criticisms on the plans proposed for facilitating the interchange of goods between ships and systems of land transportation, with lengthy editorial. 4400 w. Eng News—March 10, 1898. No. 18907.

Terminal Improvements at Quincy, Ill.; Chicago, Burlington & Quincy R. R. Plan, showing the situation, with explanatory notes. 1300 w. Eng News—March 17, 1898. No. 19025.

The Railroad on West Street, New York. Discussing the scheme presented to the Dock Commissioners. A criticism of C. W. Buchholz. Extracts from an article published in the *N. Y. Journal of Commerce*. 1800 w. R R Gaz—March 4, 1898. No. 18798.

TRAFFIC.

Pooling.

Pooling—Fancies versus Facts. Editorial discussion of the address of George F. Stone, secretary of the Chicago Board of Trade. 1500 w. Ry & Engng Rev—March 26, 1898. No. 19195.

Railroad Pools. W. W. Knight. Part first gives a brief review of railroad history, the disastrous results of rate "wars," and the effect of pools in keeping the rates steady. 2000 w. Yale Sci M—March, 1898. Serial. 1st part. No. 19012 C.

Railway Regulation.

A Decade of Railway Regulation. Henry C. Adams. A review of the ten years' experience with the federal Act to regulate commerce. 6400 w. Atlantic M—April, 1898. No. 19080 D.

Rates.

See Street and Electric Tramways.

Standard Code.

Standard Code on the Southern Pacific. Calling attention to some of the rules in the revised edition recently issued for the operating department. 1000 w. R R Gaz—March 18, 1898, No. 18997.

STREET AND ELECTRIC TRAMWAYS.

Brake.

Adhesive Rail Brakes. (Adhäsion Vermehrende Schienenbremsen.) Max Schiemann. Describing a form of tramway brake acting by the adhesion of magnetized brake shoes directly to the rails. 1000 w. Deutsche Zeitschr f Elektrotechnik—March 15, 1898. No. 19273 H.

Brooklyn Elevated.

Electrical Equipment of the Brooklyn Elevated railroad. The system to be used, and illustrated description of the Short motors, showing the method of suspension, and the relations between motor and truck. 1400 w. Elec Eng, N. Y.—March 3, 1898. No. 18762.

Commutators.

Commutator Segments for Electric Traction Apparatus. Frank X. Cicott. Presents the difficulties in this field and the improvements made, giving the accepted use of the largest consumers. Ill. 1500 w. Ry Wld—March, 1898. No. 18967 A.

Dayton, Ohio.

The Street Railways of Dayton, Ohio. An illustrated account of the railways which are under the control of three distinct companies. 3800 w. St Ry Jour—March, 1898. No. 18800 D.

Elevated Roads.

Electric Traction on Elevated Railways. (La Traction Electrique sur les Chemins de Fer Elevés.) A discussion of the applicability of an electric elevated railway for Paris, based on the experiences of Chicago, New York and Brooklyn. 3500 w. 1 plate. La Revue Technique—Feb. 25, 1898. No. 19205 D.

Feeders.

Electric Railway Feeders. George T. Hanchett. On the calculation of steel feeders. 1200 w. Am Elect'n—March, 1898. No. 18831.

Glasgow Subway.

Glasgow District Subway. Data and illustrations relating to this underground passenger cable railway. 1800 w. St Ry Rev—March 15, 1898. No. 19044 C.

New England Railway.

A Recent New England Railway. An illustrated description of the new line connecting Torrington and Winsted, Conn. 5000 w. St Ry Jour—March, 1898. No. 18803 D.

Paris.

Electric Traction in Paris. (La Traction Electrique à Paris.) Emile Dieudonné. Giving profiles of suburban lines out of Paris and description of accumulator and trolley motor cars soon to be installed. 3000 w. 1 plate. La Revue Technique—March 10, 1898. No. 19207 D.

Polyphase Motors.

Polyphase Current Motors for Railways. (Drehstrombahnen.) Max Schiemann. A discussion of the applicability of polyphase currents for railway service and a description of the application to the Jungfrau mountain-road. 2500 w. Deutsche Zeitschr f Elektrotechnik—Feb. 15, 1898. No. 19272 H.

Power Plant.

Test of the Brockton Street Railway Plant. Illustrates a plant representing the most advanced practice and describes an unusually complete test. 1800 w. Eng Rec—March 5, 1898. No. 18895.

Rail Bonding.

Rail Bonding as a Power Saver. H. C. Chase. Read at the Texas-Mexico Convention. Considers that rail bonding as a power saver depends upon the bonds being of ample capacity, perfect connections and large contacts. 1100 w. St Ry Rev—March 15, 1898. No. 19048 C.

Rapid Transit.

Rapid Transit in New York. A synopsis of the franchises which the N. Y. Rapid Transit Commissioners offer to the Manhattan Ry. Co. 1200 w. R R Gaz—March 25, 1898. No. 19115.

Rates.

Freight and Passenger Rates on Interurban Lines. Latest views of street railway managers on this subject. 2800 w. St Ry Rev—March 15, 1898. No. 19046 C.

Salt.

The Use of Salt. The question as to whether street railways may be permitted to use salt, as brought forward in Binghamton, N. Y. 1800 w. St Ry Rev—March 15, 1898. No. 19045 C.

Snow Storms.

Story of the Great Storm. A record of the fine work on various street railways in New England in opening the lines, giving valuable experiences. Ill. 9800 w. St Ry Rev—March 15, 1898. No. 19043 C.

Street Railways.

The Relations Between Municipalities and Street Railway Companies. Editorial on the report of the committee appointed by the governor of Massachusetts to consider these relations. 3000 w. Ry & Engng Rev—March 12, 1898. No. 18992.

Surface Contact.

Kingsland's Surface Contact System of Electric Traction. Illustrated description of the apparatus and method of working of this system. 1600 w. Elec Rev, Lond—March 18, 1898. No. 19158 A.

Vienna.

The Operation of the Vienna City Railway. (Der Betrieb der Wiener Stadtbahn.) Gustav Gerstel. A discussion of the first year's operation of the Vienna elevated railway, with especial reference to speeds, signals, and the distribution of transportation. 7500 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Feb. 25, 1898. No. 19256 B.

IMPROVED MACHINERY

NEW PROCESSES—NEW APPLIANCES

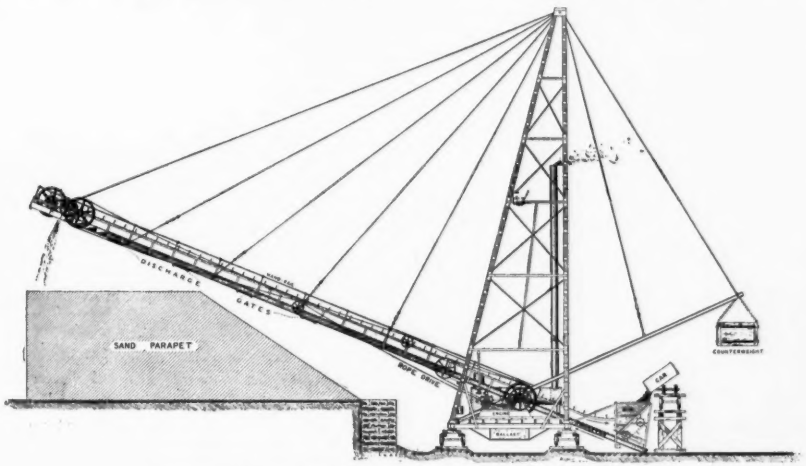
The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Machinery for Building Fortifications.

AT Key West, which commands the entrance to the south-eastern ports of the United States, is being built what would seem to be an invulnerable fortification. Breastworks 20 ft. high and from 50 to 60 ft. thick at their base and about 30 ft. at their top are being constructed from the limestone sand dredged from the coral reefs of the Florida Keys. It is understood that the revetment, when it is completed, will be 2,000 ft. long.

The Venable Construction Co., of Atlanta, Ga., have contract for building this sand parapet, and are installing the latest-improved machinery to complete the work economically and expeditiously. The accompanying outline sketch will show the machinery to be employed. It is all contained in a vertical steel tower 75 feet high, from the top of which the two booms of steel construction are guyed. The boom to the left of the tower supports a conveyor 108 feet long. That to the right carries a box loaded with stone and sand weighing about 24,000 pounds, as a counterpoise to the weight of the conveyor and its boom.

The sand, after being dredged from the sea, is brought in a plastic state to the steel receiving bin located above the foot of the conveyor. Cars of 2½ cubic yards capacity bring the dredged material up an inclined trestle and drop it to the bin *en masse*. The bottom of the bin is hopper shaped and fitted with a regulating gate, so that the material will feed itself to the conveyor automatically and in the proper quantity. The sand is scraped along the trough of the conveyor by flights suspended from two strands of a rugged chain. The attachments which secure the flights to the chains not only serve as wearing shoes for these scrapers, but place the chains entirely outside of the conveyor trough, thus keeping them away from the sand.



CONVEYING PLANT FOR BUILDING FORTIFICATIONS AT KEY WEST.

The office of the conveyor is to place the coral mud so that it will form breastworks of the dimensions already given. To accomplish this, dis-

charge doors are put at such intervals in the bottom of the conveyor trough as to make it possible to drop the material anywhere along the line of the 60-ft. thickness referred to. These doors are readily opened and closed and are easy of access, as is all the machinery of the conveyor; there is a foot walk along its entire length. The sand is deposited so that the thickness of the parapet is gradually decreased as the height is increased, till at the 20-feet summit it is about 30 feet thick.

Coral mud weighs approximately 2500 pounds per cubic yard. As two and a half times this amount is dumped into the receiving bin at one time, and as the material at the rate of 135 tons per hour is discharged from the conveyor at any one of the trough doors, the equilibrium established in the unloaded machine might be disturbed by the varying weights thus put upon the two booms. To make perfect stability certain, a stone-and-sand ballast box of 15,000 pounds' capacity is suspended from the floor beams of the tower, which also renders it proof against any tendency to sway in case of strong winds.

The entire machine is carried on T-rail tracks by four-wheel trucks placed under the corners of the tower, and on these tracks it may be shifted to the positions necessary for it to assume to build up, section by section, the 2000 feet of breastworks, the tracks running parallel with the line to be fortified. On the floor of the tower are placed the boiler and engine for driving the conveyor. The engine is a 40 horse, and power is transmitted to the head of the conveyor by means of a manila-rope drive, as shown by the sketch.

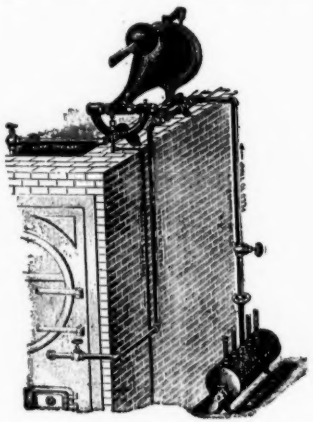
This outfit was designed and is being erected by the Link-Belt Engineering Co., of Nicetown, Philadelphia. While it will be the first plant installed by them for the purpose of building fortifications, it is yet well within the wide range of their experience in designing and building elevating and conveying machinery and iron and steel structural work. Their Modern Methods catalogue gives a very comprehensive idea of the field they cover. They also have a vest-pocket edition of this book, intended especially for the convenience of superintendents and foremen, and will mail a copy of either on request.

A Steam Trap that Pumps Water.

THE Bundy steam return traps, under certain conditions, will feed water to a boiler better than will a pump. For instance, they will return to the boiler the water from a feed-water heater supplied by city water pressure, providing only this water has been heated, by exhaust steam or otherwise, to a temperature of 100° F. or more.

These traps will also return to the boiler the waters of condensation from drying coils or from steam separators. Steam users would do well to look at a device which replaces the boiler-feed pump, or that still more expensive boiler feeder, an injector.

The Bundy trap is put into operation by the weight of water. The water accumulates in the pear-shaped bowl (see cut) which, as soon as it is filled, settles in the frame, opening the steam valve admitting steam to the trap from the boiler; this closes the check valve through which the water has been coming to the trap, and equalizes the steam pressure in both trap and boiler; the water, of its own weight, then passes into the boiler. The trap bowl from which the water has been discharged, being thus lightened, rises in the frame, closing the steam valve and opening the air valve



THE BUNDY TRAP AS A PUMP.

of the trap, which fills again with water. It will be seen at once that the trap, being open to the air, will fill quickly and at each discharge will put into the boiler from three to fifteen gallons of water just as positively as a pump and at no expenditure of steam, beyond the small amount used in the trap while it is discharging, and this serves to heat the trap bowl so hot that the temperature of the water is raised 15 degrees in passing through, affording full compensation for the little steam used in the higher temperature of the water flowing from the trap.

A good trap will repay its cost, usually, in the first few months saving of coal. One party reports a saving of three-fourths of a ton of coal a day, paying for the trap in a few weeks.

The Bundy Trap is also made to discharge water into a tank or sewer, and is so constructed that, where used to its fullest capacity, it dis-

charges uninterruptedly. The discharge-capacity can be readily calculated. There are no ball floats to cut down the capacity; everything is exterior, easily got at, and so simple as to prevent any part getting out of order.

The Bundy return and tank traps are made exclusively by the A. A. Griffing Iron Co., 66-68 Centre street, New York, with branch offices at Boston and Philadelphia, and works at Jersey City.

A Jeanesville Mine Pump.

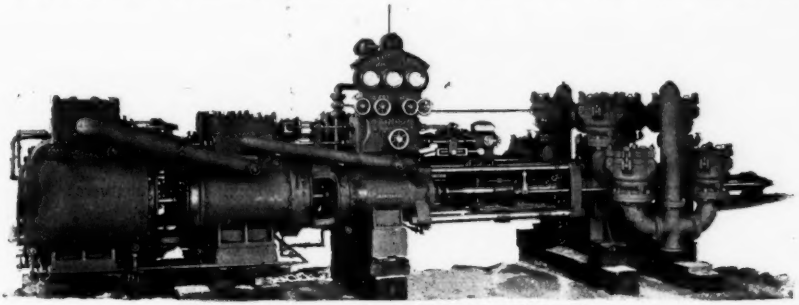
THE Jeanesville Iron Works Co. of Jeanesville, Pa., have recently built, for one of the Colorado silver mines, a duplex triple-expansion plunger pump capable of pumping 600 gallons of water per minute against a head of 900 ft. The steam cylinders are 11″,16″, and 26″ dia., all of 24″ stroke. The intermediate and low-pressure cylinders are steam jacketed, as also are the heads of the low-pressure cylinder.

The piston rods are 3″ diameter, of hammered open-hearth steel, and are of the same size for all three cylinders; the pistons are secured by a split nut, which is threaded on the inside to suit the rod, turned taper on the outside and fitted into a corresponding taper in the piston head. These split nuts are held fast, on the rod and piston, by a sleeve nut slipped over the rods and threaded into the piston head; by this arrangement, the rod can be removed without tearing down any of the pump, or disturbing its alignment. The low-pressure piston is removed from the back in the usual manner, the intermediate and high-pressure pistons through large openings provided for that purpose in the cradles connecting the cylinders. The valve motion is of the well-known duplex pattern; the intermediate and low-pressure slide valves are balanced; the high-pressure is fitted with cut-off valves, adjustable by hand, allowing a range of cut-off from five-eighths to full stroke, and is provided with a pointer indicating the amount of cut-off. All the operating valves are brought to one side of the pump, and the hand wheels are mounted on a cast iron "gauge board," together with the steam, water and vacuum gauges, making the pump convenient and easy to operate.

The water cylinders are four in number, bolted together in pairs, with a recessed-joint flange between each pair, and are supported on heavy cast-iron cross feet. The water end is connected to the steam end by 3″ polished-steel rods, passing through securely-braced bosses cast on high-pressure cylinders at one end, and at the other end through bosses of a heavy flange which is bolted, not cast, to the water cylinder.

The plungers are of extra hard iron, 7″ diameter and 24″ stroke, and are outside packed, connected together trombone style, by 2″ cold-rolled steel rods. The plunger crossheads are of cast steel, sliding in guides, both at back and front.

The pot-valve chambers each contain four valves, which are of bronze, faced with the best vulcanized rubber, with phosphor-bronze caps covering the entire upper surface of the rubber as well as its periphery. The valve seats are of bronze, driven into bored recesses in the valve chamber. The condensing apparatus is of the Jeanesville duplex independent jet type, especially designed for mine use, and has proved a very durable, simple and efficient machine.



JEANESVILLE DUPLEX TRIPLE-EXPANSION MINE PUMP.

Armstrong's No. 0 Pipe Machine With Power Attachment.

THE recognized merit of the No. 0 new hand pipe-threading machine, the latest addition of the Armstrong Manufacturing Company to their large line of improved pipe machines now in general use by the trade, has created a wide demand from mills and factories for the same machine to be run by power.

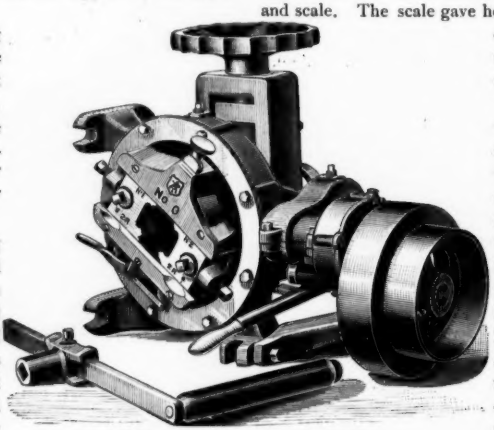
To meet the market, The Armstrong Mfg. Co., have lately brought out an attachment which can

easily be fitted to the machine, turning it at once into a power machine.

This attachment is composed of an extra gear and pinion with two-cone pulley, which is slipped onto the pinion of the second speed and has a stay bolted on the base to support it, making it perfectly strong.

The engraving shows the machine with attachment ready for the belt. The No. 0 machine is made for threading pipe ⅛″ to 2″ and bolts from ¼″ up to 1-½″.

The working parts are all encased so as to keep them free from chips and dust. The gear of the die head does not bear on the head when revolving, and therefore does not wear loose by friction. This makes it impossible for the operator to produce a "drunken" thread.



THE ARMSTRONG PIPE CUTTER.

Full particulars can be obtained by addressing the manufacturers, either at Bridgeport, Conn., or 139 Centre street, New York City.

Test of a Cochrane Separator.

THE results of a test of a six-inch Cochrane horizontal steam separator are furnished by the Harrison Safety Boiler Works. The test was made for the Edison Electric Illuminating Company of Boston by Mr. Chas H. Parker, whose report is as follows:

"In the preliminary runs a calorimeter was used on the inlet and outlet of the separator. No practical results were obtained, as a fair sample of steam could not be obtained for the inlet calorimeter.

"This calorimeter was situated in a horizontal pipe near a bend which seemed to squeeze the moisture out of steam, so that the sample obtained was much dryer than the average of the steam in the pipe, as shown by the amount of water extracted by separator. The outlet calorimeter undoubtedly obtained a fair sample of steam as it was so close to the working part of the separator that no moisture could have dropped out.

"Besides, the pipe and separator are thickly covered with magnesia insulation. In the final test, the inlet calorimeter was discarded and the drain of the separator was connected to an entropy tank, a carefully calibrated volumetric tank, having a thermometer well inside to allow taking temperature readings and a gauge glass in front to allow taking volume from attached scale.

"The air-pump discharge of the engine was run into a tank fitted with a known orifice and a gauge and scale. The scale gave heights above centre of orifice in feet, and tenths and hundredths of feet.

"The head of water in tank was adjusted so that the water entering tank, and the flow from orifice were equal; then, the engine load being constant, the head changed but very little. The load on the engine and the steam pressure were very steady throughout the test.

"Two minute readings were taken on the calorimeter thermometers and the pressure gauge on engine. Five-minute readings were taken on the orifice tank and on the entropy tank. The results were:

Length of run	3-4 hrs.
Average pressure of steam, per sq. in.	158 lbs.
Temperature of upper thermometer in calorimeter on outlet of separator	368.5° F.
Temperature of lower thermometer in calorimeter on outlet of separator	291.7° F.
Normal temperature of lower thermometer, when steam is at rest	292.9° F.
Degrees cooling as shown by lower thermometer	1.2° F.
Moisture in steam delivered by separator as shown by cooling of lower thermometer	.06%
Water discharged from separator into entropy can, per hour	52 lbs.
Steam and entrained water passing through engine, as shown by discharge from air pump of surface condenser	7359 lbs.
Steam and entrained water entering separator	7411 lbs.
Per cent. of water separated	72%
Total moisture in steam (.06 plus .72)	78%
Efficiency of separator	92.3%

(Signed) CHAS. H. PARKER.

Concerning these results the Harrison Safety Boiler Works, the makers of the Cochrane Separator, add :

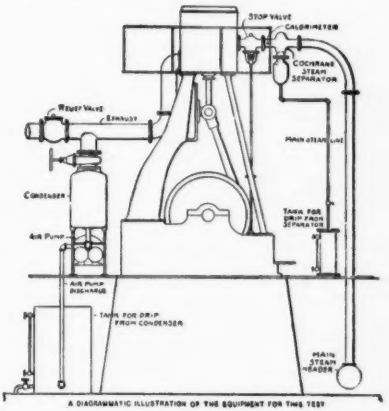
"The test is particularly interesting, for the reason that it has been conducted on different lines, so far as we know, from any other tests of similar appliances. Heretofore calorimeters have been relied upon for determining the quality of the steam entering the separator, but owing to the exceedingly high efficiency of our separators we were able to prove that there was more moisture in the steam entering than the inlet calorimeter showed.

"As it will be the natural deduction from our remarks concerning the unreliability of calorimeters in horizontal pipes for determining the quality of the steam, that all calorimeters so placed will be incorrect, we think it necessary to explain that the calorimeter used in the test referred to on the *outlet* pipe will give a fair gauge of the amount of moisture present in the steam leaving the separator, for the reason that it is very close to the separator itself, which will take out the water traveling along the bottom of the pipe. The water which has escaped the separator will be carried in the current of steam, and will reach the outlet calorimeter before it has the opportunity of falling.

"The conditions prevailing will be better understood by considering what happens in the case of the inlet calorimeter. Referring to the diagrammatic illustration, it will be observed that the steam and water ascend a vertical pipe from the main steam header, giving opportunity for the

THE COCHRANE STEAM SEPARATOR.

water to become thoroughly mixed with the steam, as its tendency will be to fall back into the steam, and then to be propelled upward ; but, as soon as the mixture starts to travel in the horizontal direction, the major portion of the water, by its own weight, will rapidly fall through the current of steam to the bottom of the pipe, and travel thence *underneath* the inlet calorimeter, which will, therefore, not have the opportunity of indicating the full amount of water present.



ARRANGEMENT OF EQUIPMENT FOR TEST.

"This holds if the calorimeter is inserted into the main line from the side. If inserted from underneath, the calorimeter would be affected by the water traveling along the pipe, and show a still more incorrect reading, that is, even wetter steam than was passing."

Gutta-Balata Belting.

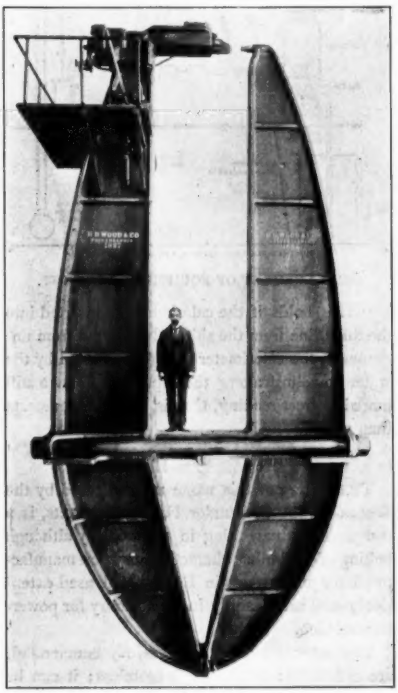
THE belting of this name manufactured by the Boston Belting Co., under Forsyth's patents, is a comparatively new thing in this country although belting of a similar character has been manufactured for many years in Europe and used extensively and successfully in that country for power-transmission.

The manufacturers claims, briefly enumerated, are as follows : the belting is seamless ; it can be run with either side next the pulley ; it can be laced and spliced like other belts ; the plies are so firmly united that separation is almost impossible ; there is no slip, if the belting is properly adjusted ; it requires no dressing, and is practically unaffected by oils and grease ; it stretches very little, does not deteriorate with reasonable age, will stand an extraordinary amount of abuse, and do plenty of hard work successfully.

The belting is said to give satisfaction in many cases when other belts have failed, and the list prices are the same as they are for regular rubber belting.

17-Foot Hydraulic Riveter.

THIS machine is specially adapted to the riveting up of locomotive boilers. The cylinder overhangs the gap, which latter is made wide enough to allow the fire-box to swing clear on the inside, a feature which is patented by Mr. S. M. Vauclain, of the Baldwin Locomotive Works, and which has the advantage of putting in a larger number of rivets (especially those around the fire-box and its junction to the shell) than can be done with a narrower gap and flush-top cylinder, as is the usual English practice. The special features of construction in the working parts are:



17-FOOT HYDRAULIC RIVETER.

1st. "The Automatic Squaring Device," which, while not exactly a plate closer, works in a somewhat similar manner. It consists of a narrow sleeve surrounding, and moving automatically in advance of, the riveting die, thus gripping the plate firmly and squaring the work up truly before upsetting commences. The result of using this device is that much truer work is obtained, as well as greater rapidity. The entire action of the machine is controlled by one lever, and no time whatever is lost in applying the squaring tool; in fact, it saves time by reducing the amount of care to be exercised by the workman in bringing the work truly into line, and is especially advantageous where the work handled is so heavy that the operator cannot easily control its motion.

2d. The machine has also triple power—25, 75, and 100 tons—the change from one power to another being almost instantaneous. The advantage of this construction is obvious. It avoids stretching the edges of light plates, which is always the result when excessive power is put upon them. It also economizes in pumping power, and has the advantage of doing the lighter work at an increased speed.

NEW CATALOGUES.

Arthur Koppel, Berlin.=A handsome album of installation of portable and permanent railways, with reproductions of handsome and interesting photographs of work in all parts of the world.

The National Pipe Bending Co., New Haven, Conn., U. S. A.=Small catalogue of the National Feed Water Heater, with table of percentage of fuel savings; also illustrations of various forms of coils of iron, brass and copper pipe.

The O. S. Kelly Co., Springfield, Ohio, U. S. A.=A tasteful little pamphlet catalogue of steam rollers especially adapted for golf links, with illustrations of grounds where the Kelly rollers are used.

Bennett Amalgamator Mfg. Co., Denver, Colo., U. S. A.=The Bennett System for Placer and River-Bed Mining. A descriptive catalogue of the Bennett electrically operated shovels, dredges and amalgamators, especially designed for placer and river-bed mining. Interesting and valuable data are given concerning various methods of working placer mining plants.

Iron Clad Mfg. Co., New York.=Catalogue No. 13. Illustrated list of plumbers' supplies, including "iron clad" range boilers, expansion tanks and boiler stands; also gas and gasolene water heaters.

The Newark Machine Tool Works, Newark, N. J., U. S. A.=Horizontal Boring and Drilling Machine pamphlet, with photogravure illustration and detailed description.

A. A. Griffing Iron Co., New York.=Catalogue of Steam Specialties, including the Bundy separators, feed-water heaters, low-water alarms, exhaust heads, and steam traps, with descriptive lists and numerous testimonials.

National Cycle Manufacturing Co., Bay City, Mich., U. S. A.=Illustrated descriptive catalogue of bicycles, with specifications, and details of parts.

Standard Steam Specialty Co., New York.=Pump governors, damper regulators, steam separators, reducing valves, and other appliances for use in steam plants.